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Railways, Street Railways, Elevated and Cable Railways, Highways, Bridges, Tunnels and Canals, Water Works, Artesian Wells, Irrigation, Sewers, Streets, Electric Light and Power, Contract Prices, Miscellaneous Contracts and Supplies.

INDUSTRIAL NOTES.....364

An ordinance requiring fenders for electric cars has been passed by the city council of Baltimore, Md., and signed by the mayor. It requires all the street railways in that city to place car fenders in front of each car, to prevent possible accidents to persons or animals. The companies are given three months' time to comply with the ordinance, at the expiration of which a fine of \$5 a day will be imposed on each car unprovided with guard or fender. In commenting on this provision the mayor says: "Of course, it will cost the companies something to get these fenders, but they cannot expect to be permitted to go on killing and maiming people because it will cost them a few dollars to prevent it."

A fast run was made recently by a special train consisting of an engine, baggage car and sleeping car on the Baltimore & Ohio R. R. The run was from Akron, O., to Chicago, 352 miles, and was made in 8 hours and 20 minutes. The run over one division of 128 miles from Garrettsville, Ind., to Chicago, was made in 115 minutes, or at the rate of 65 miles per minute.

Another project for a down-town loop line in Chicago is reported in the newspapers, and it is said that an organization is to be effected under the name of the Property Owner's Elevated R. R. Co. It is proposed to build a single track elevated line operated by electric motors through the streets of the business district to connect the Alley, the Metropolitan and the Lake St. elevated lines. It is proposed to carry all passengers free on this system, the company securing its revenue by traffic contracts with the existing elevated railway companies. Another company recently organized proposes to connect the downtown terminals of the various elevated railways with an elevated moving sidewalk, similar to that operated on the pier at the Columbian Exposition.

An electro-pneumatic interlocking plant has been installed at the crossing of the Delaware, Lackawanna & Western and the Western New York & Pennsylvania railways near Buffalo. The work was done by a new company in the railway signaling field, the Railway Electric & Auto-Pneumatic Signal Co., of Rochester, N. Y. Dr. J. H. McCartney is its President, and Mr. Frank L. Dodson is Chief Engineer.

The standard ore car of the Duluth & Iron Range R. R. was described and illustrated in our issue of Oct. 26, but some few further particulars have since been received from Mr. H. S. Bryan, Master Mechanic, as follows: Weight, 24,400 lbs.; capacity, 53,760 lbs; number in service, 575; approximate cost, \$450 each. The

cars were built by the Wells French Co., of Chicago, Ill.

The contract for deepening Aransas Pass has been let to Manning & Cameron, of New York, by the directors of the Aransas Pass Deep Water Co., according to press reports. It is stated that Manning & Cameron represent a syndicate of Eastern capitalists, and have already deposited \$10,000 as a guaranty that work will be begun within 60 days. The Deep Water Co. has already built about 1,400 yds. of jetty into the Gulf, and the new contractors will extend it 1,500 yds. farther. The contract price is \$113,000.

New contracts have been let for Sections 2, 3 and 4 of the Chicago Drainage Canal, upon which work was abandoned by McArthur Bros. owing to a dispute regarding the classification of the cemented conglomerate encountered. Sections 2 and 4 were reawarded to McArthur Bros. at 50 cts. per cu. yd. for glacial drift and 80 cts. for rock on Section 2, and 49 cts. for glacial drift and 50 cts. for rock on Section 4. In the original contract the prices for these two sections were 28 cts. and 91 cts. for Section 2, and 27 cts. and 86 cts. for Section 4. Section 3 was awarded to Gilman & McNeil, of Marshalltown, Ia., at 56 cts. per cu. yd. for drift and 70 cts. for rock.

The most serious railway accident of the week was a derailment on the Pennsylvania R. R., near Trenton, N. J., Oct. 25. One of the middle cars of a freight train jumped the track, owing, it is said, to a broken axle, but this is probably conjecture. Several other cars followed and were piled in a heap, four men being killed. The wreckage blocked one of the passenger tracks and was run into by an eastbound express train, the engine and four cars being derailed but only one man was seriously hurt.—Another serious accident was the derailment of a freight train on the Toledo, Ann Arbor & Northern Michigan R. R., near Hamburg Junction, Mich., Oct. 25, caused by the subsidence of the track over a sinkhole. The train consisted of 20 freight cars, with two oil tank cars and four coal cars next to the tender. These cars piled up on the engine and the wreck caught fire immediately and the engine-man, fireman and front brakeman were burned to death. It is said that the track has sunk several times, no amount of filling seeming to secure stability.

The center span of a bridge being built over White River, at Henderson Ford, two miles from Brooklyn, Ind., gave way Oct. 25, carrying five men down, of whom one was killed and two were seriously injured.

The St. Clair & Lake Erie Ship Canal Construction Co. is a new corporation, organized under the laws of Wisconsin, to build a canal from a point near the southeasterly corner of Lake St. Clair, in Essex and Kent counties, Ontario, and run 30 miles to a point southeast of Point Pelee, on Lake Erie. The difference in the water level between the two lakes to be connected is not more than 4 ft., and upon both routes surveyed there is said to be no deeper cutting needed than 34 ft. No rock has been encountered during the preliminary survey, and a neutral entry at each end will facilitate the work and will assist in rendering locks needless. Capital amounting to \$4,000,000 has been secured, it is reported, and is ready as soon as the formalities attending the securing of a charter from the Dominion Government have been fully completed. Among the officers of the company are C. A. Towner, Duluth, Minn., President; E. Armit, New York, Consulting Engineer, and W. Potter, Minneapolis, Secretary.

The United States battle-ship "Oregon" was launched from the yards of the Union Iron Works, of San Francisco, Cal., on Oct. 27. Her principal dimensions are: Length on water line, 348 ft.; extreme breadth, 69½ ft.; draft, 24 ft.; displacement, 10,288 tons. She is provided with twin screw, triple expansion engines, with 34½ ins., 48 ins. and 75 ins. cylinders and a 42-in. stroke. There are four double-ended boilers 18 x 15 ft. and two single ended boilers 8½ x 10 ft. Each boiler and engine is in a separate compartment in order to localize possible injury. The armor protection consists of a 7-ft. plate of side armor running for 148 ft. amidships, with a 2½ ins. steel deck and the usual turret and barbette armor. The batteries will consist of four 13-in., eight 8-in. and four 6-in. breech-loading rifles, 20 six-pounder and four one-pounder rapid-fire guns and four Gatling guns. In addition there will be six torpedo tubes: one bow, one stern and four broadside. The appropriation for the vessel was made in June, 1890, and her keel was laid in November, 1891.

The Ferris Wheel has already proved enormously profitable, having earned in all, up to about Oct. 20, \$820,000, \$300,000 of which goes under the contract to repay the company for the cost of the wheel, the remaining \$520,000 being divided equally between the company and the Exposition. We understand these earnings to be net, or in addition to running expenses. They seem to indicate that, nearly all the visitors to the grounds since the wheel began running have made

one trip in it. Nearly all the concessionaires are said to have made money, their own profits after all deductions aggregating some \$4,000,000.

An automatic block system for single track electric railways has been developed by General Manager H. H. Littell, of the Buffalo City Ry. Co. Two passing sidings are located quite near each other, but with a square turn between, and cars have frequently met between them. A signal lamp has therefore been placed at each switch and is automatically lighted whenever a car passes the other switch to enter the block between the two.

The general removal of railway crossings in the city of Chicago seems no nearer accomplishment now than at the beginning of the summer. The consulting engineer appointed to report a plan recommended one which involved a compromise between the claims of the city officials and those of the railway companies. As neither party had reached the point where they were in any mood for making concessions or compromises the engineer's report was promptly shelved without a good word from either side. The Corporation Counsel of Chicago has now taken up the cudgels for a fight by bringing suit to eject the Chicago & Western Indiana R. R. from a large mileage of streets which are now occupied by its tracks. It is over the Western Indiana tracks that an entrance to the city is secured by the Chicago & Eastern Illinois, Wabash, Chicago & Grand Trunk, Chicago & Erie, Louisville, New Albany & Chicago and Atchison, Topeka & Santa Fe railways. The company claims its right of way under an ordinance granted by the trustees of the old Town of Lake. The corporation counsel claims that the trustees exceeded their legal powers in passing this ordinance, and that it is therefore void. He has served notice to remove the tracks from the streets specified before Nov. 5, otherwise they will be removed by the city.

The much coveted contract for the great 5,000-HP. dynamos which are to be installed at Niagara Falls by the Niagara Falls Power Co., has been awarded to the Westinghouse Electric Co. The contract calls for three alternating dynamos, each of 5,000 HP., having a frequency of alternations of 25 per second, and generating a two-phase current of 2,000 volts. Step-up and step-down transformers are to be used for the long distance transmission of this current. These dynamos will be by far the largest and most powerful ever constructed. The largest dynamo thus far built is claimed by the General Electric Co. to be the 1,500 K-W. (2,100 E. HP.) direct current generator in the power station of the Intramural Ry. The Niagara Falls machines will have more than double this power.

The number of public buildings now under construction or for which appropriations have been made by Congress is 120, according to figures given in the "U. S. Government Advertiser." The following table shows in a general way the progress of work and cost of these buildings:

Progress of work.	No. build- ings.	Total cost.	Amount appropriated.	Amount to be available July 31, 1893.
Under construction ..	71	\$24,569,320	\$20,846,430	\$3,722,890
Plans commenced ..	27	2,617,500	2,072,500	545,000
Plans not commenced ..	22	11,018,910	5,688,302	5,330,607
Total	120	\$38,205,731	\$28,607,232	\$9,598,498

About 51.6% of these buildings are located in the states north of the Ohio and east of the Mississippi rivers, 31.6% in the Southern and Southwestern States and 16.8% in the Western and Pacific States. Twelve of the 120 buildings will cost over \$1,000,000, five \$2,000,000 or over and one \$3,554,000. Nearly all of the buildings are for court and custom houses and post-offices.

Seventeen feet of water is now available over the bar at the mouth of the Sabine Pass, on the gulf coast. The improvement which was made at this point was effected by the construction of two jetties parallel and about one mile apart, extending out into the gulf, and the dredging of the channel between them. The east jetty is 17,100 ft. long, and 16,700 ft. have been completed, and the west jetty is 14,700 ft. long, and about 7,000 ft. have been completed. It is stated that the bar has responded quickly to the jetties and shows no tendency to re-form. The work was done by the Government.

An electric conduit system for street railway propulsion has been devised by Mr. H. Peterson, of Milwaukee, Wis., which, it is claimed, successfully solves the problem of keeping the conduit free of moisture. The system consists of a large conduit for the drainage water, with a small conduit inside for the electric wire, which is so arranged that no water can enter it.

THE LOVE CONDUIT SYSTEM FOR ELECTRIC RAILWAYS.

Some interesting particulars of the Love underground conduit system for electric railways were given by Mr. Herbert Claude and Mr. M. D. Law, at the annual meeting of the American Street Railway Association at Milwaukee, Wis., in October. This conduit system, as applied at Chicago and Washington, has been described in our issues of March 19, April 26 and Dec. 29, 1892, and April 20, 1893. The statements made at the convention are as follows:

Mr. Herbert Claude: In Washington we have an underground conduit forming an extension of an overhead trolley line. It is about $1\frac{1}{2}$ miles long, double track. We had already laid about a mile of track in the city when we found we could not put up poles for overhead wires, and the question came up what we were to do. We considered the Budapest conduit line (Eng. News, Jan. 31, 1891; May 19, 1892, and June 1, 1893). It had been running successfully, we understood, but we did not feel disposed to go to work to contract for something which we were not sure of, that was not made in this country, and in which the voltage was different from what we were using on our overhead lines. Then we had the storage battery to fall back on. We did not think it possible to try that, for the simple reason we would have to put up a new power-house and have new cars, etc., and after it was done we might have it all on our hands. The Metropolitan line was already trying the storage battery in our city. We could have recourse to the cable; but we did not think that with our light traffic it would pay to expend 80% to haul rope and 20% to haul passengers. We then determined to try the underground system. We went to the best electricians to get their opinions. We were told that electrically it was all right, but the principal trouble had been in the construction. We thought we could overcome that, and we started. We put down $1\frac{1}{2}$ miles of track, and have had it in successful operation since March 4. It runs on the outskirts of the city and then joins to the overhead trolley. We are using the same cars and the same motors. We built a separate power-house to give it a thorough test. We know it is a success, and I do not see any reason why, if it will run for $1\frac{1}{2}$ miles, it will not run for any distance. It can be continued as any ordinary line is continued. The current is the same, and I do not consider it anything new. It is simply the overhead line with the wires underground. It is the Love system. Mr. M. D. Law built the conduit, and put the wires in. We did not have any very cold weather during March; we had some snow. In the overhead system, the return current comes back through the rail. If it is covered with sleet and ice it gives a great deal of trouble, as you know. The underground system does not give us any trouble in such cases, for the current is returned through the wire in the conduit, and we do not depend on the rail for the return current at all. It makes no difference how much snow there is on the rail, you go ahead just the same. In regard to the conduit filling with snow, I do not think there is any chance of its filling completely. It can be looked after just as the snow is looked after on top. I run a sweeper through it once a week. A broom that fits the conduit is attached to the car, and the car goes along and the conduit is swept out. Every hundred feet there is a manhole and trap, and the dirt and refuse drops below the conduit, and a cart comes along and it is taken up. Snow, I think, can be looked out for in the same way. The slot is only $\frac{5}{8}$ -in. wide, and I do not think that much snow will drop down that. I think the snow question is easily managed.

Mr. M. D. Law: The Love underground conduit has iron yokes weighing about 360 lbs. each, with an opening 14 ins. wide by 20 ins. deep. This yoke has square ends to support the rail, and is embedded in concrete, so that the entire track construction is extremely solid and rigid. The shallowness of this yoke removes the necessity of moving gas and water pipes, which, you all know, increases the cost of construction in cable railway work to a great extent. In other words, we just climb over the top, and still have a large enough conduit, by sweeping, as Mr. Claude says, to keep it clear of all refuse and snow. The slot rail that is attached to this yoke is made of steel, and is made U-shaped, having a side bearing of $1\frac{1}{2}$ ins., and projecting into the conduit 5 ins. on the inner side. The insulator is attached to the yoke upon shouldered bolts, and the insulator is allowed to move about $2\frac{1}{2}$ ins. laterally, to allow for expansion and contraction. Any expansion or contraction in the rail will not affect the insulator. That is placed under the slot rail, allowing a $\frac{1}{4}$ -in. air space. I have been repeatedly in the conduit and have been unable to burn a candle in it, on account of the extreme draft. There is a constant draft around the insulator, which prevents any collection of moisture. In the stormiest weather you

can take off the slot rail and find a dusty insulator. The slot rail is so attached to the yoke that by removing the bolts in the yoke we can remove the slot rail and get ready access to the rail for any repairs that may be necessary. It takes about 15 minutes to remove one 32-ft. length of the slot rail. The trolley wire is suspended on this insulator at a point about even with the lower edge of the slot rail, and about 2 ins. from it, so that it is entirely out of sight and out of reach. The small boy cannot play with it with his wire; if he does reach it, it is impossible for him to get a shock, as the wire will lay against the slot rail. We carry a metallic circuit; that is, both positive and negative wires are carried underneath the slot rail. We do not use any ground return, and keep our circuit entirely free from ground, thus nearly doubling the insulation on the motors. This wire is cut every 500 ft., and yet so arranged that it is still a continuous wire from end to end, so that you have a perfectly smooth surface. At every 500 ft. we provide a hitch, and provide switches by which we can, if desired, cut out any one section of this line. If trouble should occur in one section you can cut out either the positive or negative in either track, and still run your cars without any interruption.

As Mr. Claude has said, this underground system is nothing more than the overhead system transferred from above the track. It is placed beneath the track, with suitable mechanical movements contained in the trolley and trolley carrier. The trolley carrier is fastened underneath the cars and is so arranged that as the car is moving in this direction it will drop into a V-shaped slot, and this end of it is allowed to move back and forth to provide for irregularities in rounding curves. As the car is rounding a curve you cannot detect it by being in the car and looking at the trolley that it is on the curve. The trolley is made of $\frac{1}{2}$ -in. steel, $4\frac{1}{4}$ ins. wide, with two trolley arms on the bottom, suitably insulated. It is shaped in the center to allow the wheel to move sideways, so that if the wire is not exactly straight, if it should happen to be further away than is proper, the wheel will move sideways far enough so that the trolley will remain on the wire. It has an elbow movement to facilitate the rounding of curves. It is impossible for the wheel to leave the wire at any point. We have run that road through all the different weather that we have experienced in Washington. We had quite a severe snow in March last, but we had no snow inside the conduit at that time, nor do I anticipate any trouble whatever from snow if the conduit is properly taken care of, simply running the broom through it once a day. It can be run through without any delay and keep the conduit free from snow. We have had two or three severe rain floods, when the water has covered the wires, and still the cars ran without delay.

There is a section of $1\frac{1}{2}$ miles of this system on the North Chicago line, running as a loop, which has been in operation since March, 1892. It went through the winter pretty well. I will state, however, that that conduit is only 11×14 ins., or only about half the size of the Washington conduit. They had some difficulty I understand in Chicago with the snow, but it was not taken care of properly. They used no sweeper; simply allowed it to run without any attempt, I believe, to clean it. As to the cost of construction, that is out of my line. I will say, however, that I believe it would be \$35,000 a mile at Milwaukee. There would be no difficulty in a longer distance. There is no moisture in the conduit. The ammeter in the power house, which should be a true indication of all current delivered by the generator, during all storms, if there is no car on the line using current, goes absolutely to zero, showing that there is no leakage of current whatever; and during those times I have put on voltmeter tests, from wire to ground, and have only found 0.1% of leakage.

FRENCH RAIL SECTIONS AND TRACK DETAILS. (With Inset.)

The accompanying series of 13 rail sections and connected parts, which we reproduce from "Nouvelles Annales de la Construction" shows in compact form the latest and best French practice as to track details as exemplified in the practice of the six great companies. The most salient fact is that all the rails which have flat bases (10 out of 13) rest on tieplates and in no case on the tie, though the rails are all light, according to modern American practice, ranging only from 60 to 77 lbs. per yd.

The weight in pounds per yard is given very exactly by the simple process of multiplying the given weight in kilograms per meter by 2. According to the usual French practice the symbol Kg. is used in place of the decimal point in giving weights. We do not translate the metric into inch units, in part

to save trouble and in part to give another practical illustration of how much more convenient the metric system is for all mechanical drawings, in that all sorts of dimensions may be expressed in whole numbers only (millimeters) without resorting either to vulgar or decimal fractions.

The other peculiarities of these sections speak for themselves, and some of them are little likely to commend themselves in American eyes. The narrow base has always been a peculiarity of French rail sections, and caused great trouble at Panama, but when used with baseplates is entirely logical and proper, within reasonable limits, though it may be questioned whether these limits are not in some cases exceeded. Figs. 2, 5, 6, 7, 8 are apparently for flat top rails, though neither the top nor corner radius is given in figures on the drawings.

TRACTION AND STREET RAILWAY TRUCKS.

The importance of preventing the slipping of the wheels of street railway and other trucks running on tracks has led Mr. Elmer A. Sperry to make some experiments to determine what methods may be adopted to this end. The results of his experiments were given in a paper before the recent meeting of the American Railway Association, at Milwaukee, Wis., of which the following is a condensation:

The instant when the wheels start to slip is the critical one, and the problem is to prevent this start.

The oldest method of accomplishing this purpose has been to couple all the drivers for absolute harmony and uniformity of movement, so that the tendency to slip of one driver will be held back by all the others, instead of by its mate only. Do we find in practice the coupling of the wheels in this way to accomplish the desired result? Does it in any way increase the traction?

Experiments have been made to determine this question, including a bi-axled equipment of the ordinary kind with an independent motor for each axle, and also equipment consisting of four, six and as high as eight separate drivers locked together and compelled to revolve in unison, being supplied with a single motor or source of power. I have found the method employed in coupling the wheels to seriously affect the traction appearing as a drawbar pull. For instance, if locomotive connecting rods are used, the necessary flexibility of truck as to parallelism of axles must be either entirely sacrificed, or, if allowed to exist, it produces a continually and constantly recurring tendency to slip resulting in a change from compression to extension of all the strains in both the truck and connecting rods. This change occurs twice in each revolution of the system, and results in a slip alternately of the wheels upon each side in amount dependent upon the lost motion existing. I have seen experiments where this periodic slip amounted to as much as 5-16 in., occurring twice each revolution, when working upon a grade without trailer.

This is avoided by steam locomotive engineers by holding the axles in absolute parallelism in a plane normal to the roadbed, and until within the last few months English locomotive builders have maintained that the parallelism of driver axles should be absolute; that is, parallel to every plane.

As to the street car truck, the flexibility necessary argues the employment of belting or rope transmission, which easily and naturally permits of such flexibility. I am free to say that no one who has not tried this experiment can form an adequate conception of the tremendous strains which motor gearing is called upon at times to withstand. I have seen as high as 14 parallel laps of rawhide rope under very heavy tension in 45° grooves slip and burn in their efforts to do work under conditions where gears are ordinarily employed, the gearing doing its work with perfect ease. No form of friction drive or friction gearing is admissible for this work. The chain drive was the first to be employed in this country, but was early abandoned on account of noise, excessive wear and journal strains, together with the impossibility of keeping it anything like adequately lubricated.

As to gearing between the axles, the bevel gear presents by far the simplest solution. This form of gearing, however, has been looked upon as wasteful of the power transmitted. This criticism is probably just in some power transmissions employing this gearing. The question is: How much more power does a bevel gear and pinion absorb than a spur gear and pinion in transmitting the same amount of power, with the conditions identical? There seems to be almost no scientific or carefully made tests of merit as to the comparative losses in transmission of power by these two classes of gears.

An exhaustive series of tests covering this point has been made by the writer, with results showing that

under practical working conditions, when the bevel gear is properly made, the losses are almost identical with spur gear; the small difference, viz., 1.74%, in favor of the cut gear, probably being due to the fact that the surfaces were somewhat rougher in the cast as compared with the cut gear. The great care exercised in these tests, and the clearness of the results, certainly speak volumes in favor of the bevel gear transmission, and constitute the first comparative tests of large transmissions under heavy strains which, to the knowledge of the writer, have been made.

Another feature bearing directly upon the all-important question of traction is that of axially mounted masses. Locomotive drivers and axles are as light in and of themselves as is consistent with required strength. The inertia of a large mass axially mounted does not allow the drivers to follow the surface irregularities of the track with anything like equal pressure, especially at high velocities. The wear and tear of roadbed is also due in large measure to the heavy masses attached directly to the axle.

A grade was built, consisting of 45-lb. T-rails rising from a spur of level track, giving a mean grade of the two rails of 12.4%. Upon this grade was run, first, a double motor equipment weighing 17,935 lbs. A dynamometer was attached to the drawbar and back to the track in such a line as not to either lift the car or drag the rear end downward in the test. Current was then applied through a variable resistance, gradually allowing the car to strain upon the dynamometer until finally the wheels slipped. Care was especially exercised on the point of gradual annihilation of the strain so as to eliminate all elements of inertia or lunging forward upon the dynamometer; after slipping had commenced it was observed that the car would slide in each instance to the bottom of the grade. Part I. of the following table gives the mean of four sets of readings.

I.—Independent Axle, Two-Motor Equipment, Weighing 17,935 lbs.

Group of tests.	Average amperes.	Average drawbar pull, lbs.	Ratio drawbar pull to weight, %.
1	1,625	200	9
2	2,250	286	12.5
3	2,150	240	12
4	2,075	230	11

II.—Coupled Axles, Single Motor Equipment, Weighing 12,685 lbs.

1	200	3,125	24
2	240	3,750	30
3	230	4,075	32
4	220	4,500	35
5	200	4,375	34.1

III.—Coupled Axles, Single Motor Equipment, Weighing 12,685 lbs. Track warped.

1	230	4,425	35
2	220	4,375	34.5
3	200	4,150	33
4	220	4,275	34

This car was run off the grade and replaced with one in which all the wheels were compelled to revolve in unison, but of much lighter weight, viz., 12,685 lbs. The dynamometer was attached in the same way and the same rheostat and source of current were used as in the previous experiment, the axles in this equipment being coupled by the bevel gears used in the gear tests above referred to. Part II. of the table gives the mean of five sets of readings taken from this car:

The car was then run off the track and the rails blocked, one rail being 12% ins. rise in 10 ft., or a 10.58% grade, the other being 17.2 ins. rise, or 14.33%, making a mean of 14.92 ins. rise in 10 ft., equaling a grade of 12.44%. Thus a considerable warp was given to the roadbed, which would at once develop any rigidity introduced into the truck by the coupling, and show up materially in the ratio of drawbar pull to the current absorbed if the equipment or any part was bound, unduly strained or working under any but perfectly normal conditions. The readings given in Part III. of the table are conclusive as to the perfect freedom of the truck while working in this warped and highly distorted position.

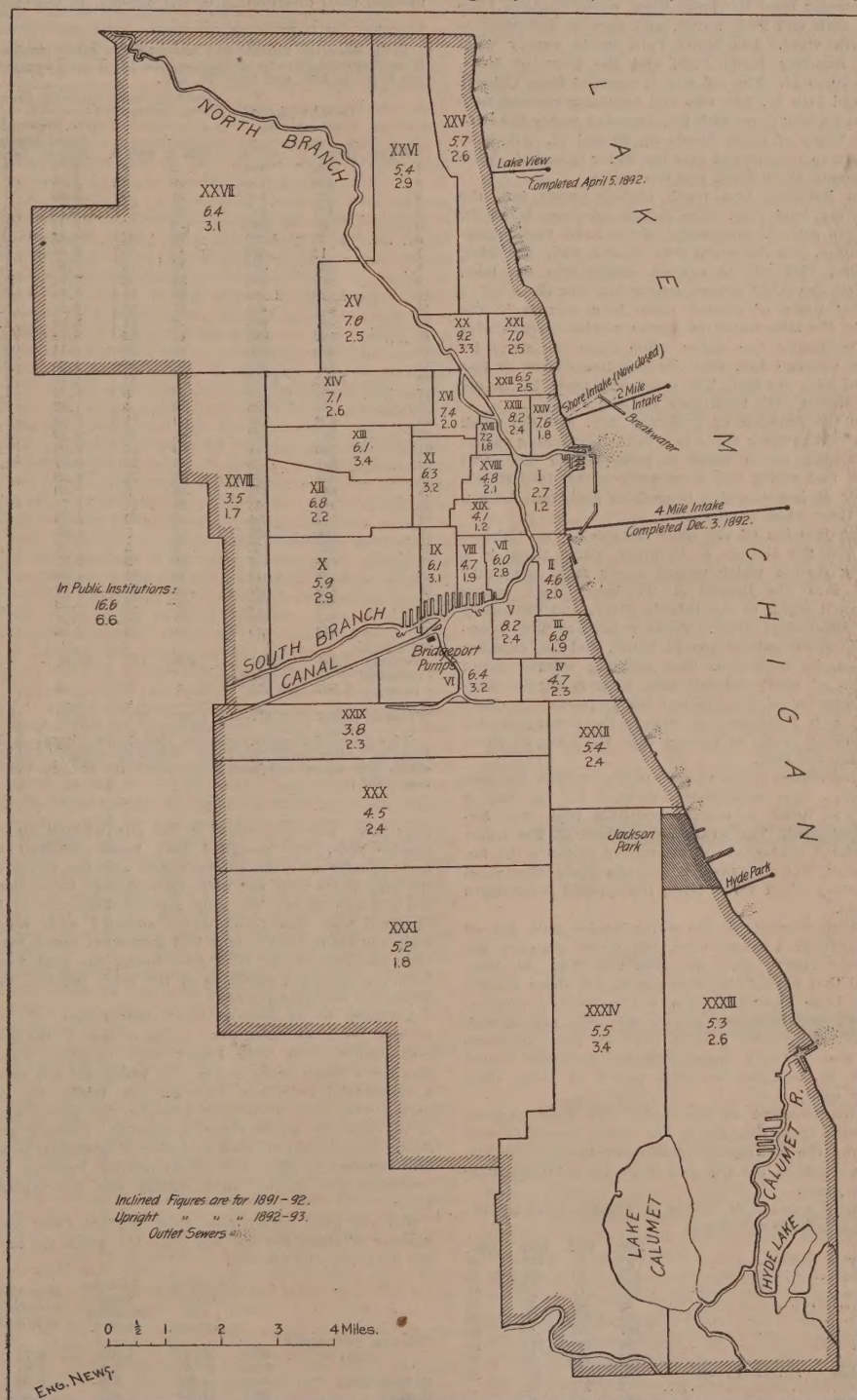
It will be readily understood that when an equipment is working upon a grade, the center of gravity of the car falls more nearly over the rear wheels, allowing the front pair to slip when independently driven. The difference in favor of coupled drivers shows a percentage of 35 as compared with 12.5 of the total weight appearing as actual pull at the drawbar under the conditions named. While working upon a level, and especially in damp weather with a slimy rail, almost the same advantage in traction will be found to exist as is here given for coupled wheels, provided always the mechanism used in coupling does not interfere in the least with the flexibility of the truck.

SANITARY ASPECT OF THE CHICAGO WATER SUPPLY.

Improvements in the quality of the water supply of Chicago have greatly reduced the typhoid fever death rate of that city, according to a paper read at Chicago on Oct. 12, before the International Public Health Congress, by Dr. Arthur R. Reynolds, Health Commissioner of Chicago, and

Mr. Allen Hazen, Chemist of the Water Department of the World's Columbian Exposition. The paper was accompanied by two large maps of the city, one showing the water-works' intakes and death rates of the city by wards for the year ending Sept. 30, 1893, and the other the same for the succeeding year; both maps also showed the sewer outlets, which were identical for the two years. These maps have been combined in one, reproduced

be seen from the accompanying map the water supply of the city is now obtained from Lake Michigan through intake tunnels extending to four points in the lake, located from about one to four miles from the shore. Beginning at the north the Lake View tunnel was completed April 5, 1892, prior to which time for a number of years this section was supplied through several iron intake pipes extending only from 1,400 to 2,000 ft. into the lake, laid



MAP OF CHICAGO SHOWING BY WARDS THE PERCENTAGES OF DEATHS FROM TYPHOID FEVER TO TOTAL MORTALITY AND THE WATER-WORKS INTAKES AND SEWER OUTLETS FOR THE YEARS ENDING SEPT. 30, 1892, AND SEPT. 30, 1893.

herewith, together with additional information regarding the sizes of sewers and some other points.

In our issue of May 11, 1893, we described at length the water supply and sewage disposal systems of Chicago as they existed the previous March.* There appears to have been little or no change in these systems since that date. As will

*In Engineering News of April 21, 1892, there was given an outline of the sanitary history of Chicago, and its mortality from typhoid fever for a number of years was compared with that of other cities.

about 50 ft. apart. The two-mile intake was put in use in 1867 and in 1874 was supplemented by a parallel tunnel. These tunnels becoming overtaxed, some six years ago, a shore intake tunnel, about 3,000 ft. long, was built at Chicago Ave., and has been used in emergencies since, especially in 1892. This intake is now permanently closed. The four-mile tunnel was completed Dec. 3, 1892, and the Lake View tunnel, about a mile in length, about eleven years ago, on July 22, 1882.

March 4, 1893, the city engineer of Chicago

stated that 85% of the city's sewage discharged into the Chicago River, and about 15% directly into Lake Michigan, a small amount going into the Calumet River, which flows into Lake Michigan only in time of flood.

The above, except the last paragraph, is practically the information given in the first part of Messrs. Reynolds' and Hazen's paper. The remainder may now be quoted from, as follows:

The water from the Lake View works supplies Lake View, 25th and 26th wards, and part of Jefferson, in the 27th ward. The Hyde Park works supply what were formerly Hyde Park and the town of Lake, wards 29 to 34. The old city is supplied from Chicago Ave. and 14th St. (the two and four-mile tunnels) with a main leading from 14th St., tunneled under the river to the Town of Lake, wards 29, 30 and 31. All, however, are so constructed that the water from Lake View may supply Hyde Park and vice versa.

From Belmont Ave. north sewers empty into the lake every half mile. The largest of these is at St. Lawrence Ave., ½ mile north of the Lake View pumping station. On the south side, at 22d, 35th, 43d, 51st, 56th and 71st streets sewers empty into the lake, while all the other sewers empty into the river.

During times of freshet there is a current in the river to the lake which of course carries sewage with it, consequently the water taken from the shore intake at Chicago Ave. must be (has been) more or less polluted with sewage. The same will apply to the old intake through the iron pipes at Lake View.

From the junction of Fullerton Ave. and the north branch of the river there is a tunnel extending to the lake through which water is pumped into the north branch, and which has a capacity of 147,750,000 gallons per 24 hours, which is used to flush that branch of the river when required.

At the junction of the south branch of the Chicago River and the Illinois & Michigan Canal there is a pumping station which pumps water from the south branch into the Illinois & Michigan Canal, which conducts it south to the Illinois River, and ultimately to the Mississippi River. These works are now pumping 407,936,000 gallons per 24 hours, and the capacity will soon be increased. The pumping works, except in times of heavy rainfall will, because of the sluggish character of the Chicago River, produce a slight current in it from the lake toward the pumps, so that it is only in times of freshet that the Chicago River flows into the lake.

The extensions of the various tunnels within the past two years have undoubtedly secured for the city a water less liable to sewage pollution than was formerly obtained. The available analyses of the water are perhaps inadequate to accurately measure the improvement, but, fortunately, we can apply that most satisfactory of all water tests, the typhoid fever death rate test.

The improvements in the water intakes have not all been made at a single date, but if we compare the two years ending Sept. 30, 1892, and Sept. 30, 1893, we find that during the earlier year the shore intakes at both Lake View and Chicago Ave. were in common use, and the four-mile tunnel was not yet opened, while for the greater part of the later year the shore inlets were entirely closed and the four-mile tunnel at 14th St. and the one-mile tunnel at Lake View were in use.

The improvement in the death rate from typhoid fever with these changes in the water supply is well shown by the accompanying table of the rates in the various wards of the city and in public institutions for the two years.

The total number of deaths, by months, since the beginning of 1890 are as follows:

	1890.	1891.	1892.	1893.
January.....	53	67	311	41
February.....	136	61	187	30
March.....	103	71	76	41
April.....	45	136	56	53
May.....	82	408	70	56
June.....	107	167	55	60
July.....	86	200	211	55
August.....	115	182	179	76
September.....	95	198	138	86
October.....	72	171	92	..
November.....	67	50	67	..
December.....	47	186	47	..
Totals.....	1,008	1,907	1,489	..

It is most unfortunate for this comparison that the old supplies were partially in use during the first two months of the latter year before the four-mile tunnel was opened; and we may believe that if this had not been the case, the comparison would have been still more favorable to the improved supply.

It is a well known fact that people using a water supply to which they are not accustomed are often more susceptible to any infection which it may contain than are those using such water regularly. A striking illustration of this was furnished by Philadelphia in the Centennial year, when the typhoid death rate was nearly doubled, while in Chicago, during the present year, for the first five months of the

Fair period, the rate has been less than half as high as for the corresponding months of the preceding year; and for the entire year under consideration, in spite of the vast numbers of visitors continually present in Chicago, there has been a reduction of over 60% in the percentage rate, and it can hardly be doubted that the improvements in the water supply have been the chief, if not the only, cause in this gratifying reduction.

It is to be noted particularly that there is no very marked local distribution of the disease. In the earlier

Table Showing Deaths in Chicago from all Causes, and from Typhoid Fever, by Wards, for the Two Years Ending Sept. 30, 1892, and Sept. 30, 1893.

Ward.	Deaths from all causes.		Deaths from typhoid fever.		P.c. typhoid to total deaths.	
	1891-2.	1892-3.	1891-2.	1892-3.	1891-2.	1892-3.
1.....	329	320	9	4	2.73	1.25
2.....	439	451	50	9	4.56	2.00
3.....	495	483	34	9	6.83	1.86
4.....	424	457	20	10	4.72	2.29
5.....	967	843	79	20	8.17	2.37
6.....	1193	1,136	73	36	6.44	3.17
7.....	112	680	43	19	6.04	2.79
8.....	682	682	32	13	4.69	1.91
9.....	912	856	56	26	6.14	3.06
10.....	1,119	1,180	60	34	5.89	2.88
11.....	587	494	37	16	6.30	3.24
12.....	863	966	59	21	6.84	2.17
13.....	709	636	43	23	6.11	3.36
14.....	868	880	62	23	7.14	2.61
15.....	960	935	73	25	7.60	2.61
16.....	1,305	1,187	97	24	7.43	2.02
17.....	395	438	43	8	7.24	1.83
18.....	413	375	20	8	4.85	2.13
19.....	939	931	40	11	4.13	1.18
20.....	457	392	42	13	9.19	3.32
21.....	546	511	38	13	6.96	2.51
22.....	614	523	40	13	6.51	2.48
23.....	831	657	68	16	8.18	2.43
24.....	369	332	28	6	7.59	1.81
25.....	418	423	24	11	5.74	2.60
26.....	710	654	38	19	5.35	2.90
27.....	188	226	12	7	6.38	3.10
28.....	227	230	8	4	3.52	1.74
29.....	629	744	21	16	3.81	2.27
30.....	1,468	1,411	52	34	4.46	2.36
31.....	439	597	23	11	5.24	1.84
32.....	464	507	25	12	5.39	2.37
33.....	621	832	33	22	5.31	2.64
34.....	632	670	35	23	5.55	3.43
Pub. institutions.	2,404	2,231	400	153	16.64	6.56
Coroners' cases.	1,550	1,923	0	0	0	0
Totals.	26,646	26,977	1,790	712	6.72	2.64

(The typhoid percentages for 1891-2 are given on the map in italics, and those for 1892-3 in upright figures, while the ward numbers are shown by Roman numerals.—Ed.)

year there was not a ward in the city without an excessive rate. The so-called best wards suffered almost equally with the poorer wards, and the wards on the lake shore were not more favored than those along the Chicago River. The only general difference to be observed was that those wards supplied with water from the Hyde Park intake had somewhat lower rates than the rest of the city; and during the past year, with the improved condition of the other intakes, this difference has disappeared.

As there is no marked local distribution of the typhoid fever, so there were no exceptions to the general improvement with better water supply. There was not a single ward in the city which did not show a substantial reduction, although, as might be expected with such a complex problem, the percentages in the different wards varied somewhat. Stronger evidence could hardly be produced even if additional proof was required to show the causal relation between the contamination of the water supply and the typhoid fever.

The mortality percentages from typhoid fever in a number of cities for the last year for which we have the data were as follows:

	Deaths from all causes.	Deaths from typhoid fever.	Mortality p.c. from typhoid.
Chicago, year end'g Sept. 30.....	1892 26,646	1,790	6.72
Philadelphia.....	1893 26,977	712	2.64
Boston.....	1892 24,305	539	2.22
Paris.....	1892 11,236	137	1.22
New York.....	1891 54,433	349	1.01
Brooklyn.....	1892 44,317	339	.90
London.....	1892 50,837	167	.80
Berlin.....	1892 86,355	424	.49
	1892 32,696	137	.42

The cities having the lowest typhoid fever death rates given above, London and Berlin, use only filtered water. London draws nearly all of its water for some four or five millions of people from the two grossly polluted rivers, the Thames and the Lea, and after filtering it supplies it to a population that is almost free from typhoid fever.

Among the improvements which will eventually still further protect the purity of Chicago's water supply may be mentioned the drainage canal. After its completion with the construction of a complete system of intercepting sewers along the entire lake front, the sewage will be turned from the lake to the Mississippi

River. In the meantime it may be a question worth considering by the engineers whether filtration would not be as cheap and effective a means of improving the supply as the further extension of the tunnels.

IRRIGATION EXHIBITS AT THE COLUMBIAN EXPOSITION.

The promoters of irrigation enterprises lost a great opportunity when they failed to take advantage of the Exposition to impress upon visitors from the Eastern states the advantages of irrigation and the part which it is playing and is destined to play in the development of a vast area of our country. It is true that the states in which irrigation is practiced had some magnificent displays of products raised with the aid of irrigation, both in the agricultural and the various state buildings, but little or no pains was taken to bring out the fact that irrigation alone made possible many of the fine exhibits which were shown.

It would not have required much space nor expense to have shown a small tract of land covered with growing crops, of various sorts, and supplied with water by a miniature irrigating system. The long, hot, dry summer which wilted and withered the growth on lands not irrigated was the most favorable possible for such an exhibit, and had two miniature farms been made on or near the grounds, one with and the other without irrigation, the object lesson would have had full effect, all through the East, as well as the West.

There was nowhere on the grounds any collective display of irrigation appliances; and the International Irrigation Congress was held at Los Angeles instead of at Chicago, where the other international meetings of the summer have been held, and where its educational effect would have been greatest on the people of the East, whom those of the West wish to incline toward national legislation favorable to irrigation.

In the lack of any collected display of irrigation appliances or methods, the following brief review is presented of some of the classes of exhibits having more or less interest to irrigation engineers.

Pumps.—The use of pumps for irrigation is limited, owing to the fact that the cost of installation and operation prohibits their use except for supplying water to comparatively small areas under a high state of cultivation, or raising a product of great value per acre. Low lift pumps are sometimes used to serve considerable areas and pumps driven by windmills are often used for garden tracts, orchards and other purposes, the size of the tracts being subject to increase with the aid of storage reservoirs.

Of course the large pump making establishments were represented in Machinery Hall and showed many kinds of pumps which could be used for irrigation where circumstances warrant the expense.

The U. S. Wind Engine & Pump Co., of Batavia, Ill., manufacture the Gause irrigation and drainage pump, made in sizes ranging from 2,000 to 6,000 gallons per hour. These are simple lift pumps, adapted especially for windmill use, the largest size being driven by a 14-ft. windmill.

The Downie Pump Co., of Valencia, Pa., makes deep well pumps, driven by steam or for use in connection with windmills. The steam cylinder is mounted on a vertical frame and the piston is driven by a pair of oscillating levers just beneath it. A somewhat similar oscillating arrangement is used in the windmill pumps. The firm also makes modifications of both the steam and wind pumps.

The American Well Works Co., of Aurora, Ill., makes a deep well pump which may be used in connection with windmills.

The Rife Hydraulic Engine Mfg. Co., of Roanoke, Va., showed a hydraulic engine or ram adapted to irrigation and other purposes.

Mr. Jos. Menge, New Orleans, La., showed a low lift drainage pump which might be used for irrigation.

Windmills.—About a dozen separate exhibits of windmills in operation were brought together near the rear of the Agricultural Building. Most of the firms represented make, either wholly or as a part of their products, metal wheels, generally of steel, and most of the firms make wheels with vanes. The United States Wind Engine & Pump Co., of Batavia, Ill., make the Halladay standard, the

United States solid wheel, the standard vaneless, of wood, and the Gem steel wind engine. This firm, as well as some of the others, also manufactures steel towers and various forms of tanks.

The Eclipse Wind Engine Co., of Beloit, Wis., makes a solid wheel, which is sold by Fairbanks, Morse & Co., at their various warehouses. The Aermotor Co., of Chicago, makes a tilting tower, designed to permit the lowering of the mill to the ground for oiling or other attention.

Miscellaneous.—Intimately connected with irrigation in many sections is the development of water from artesian wells. The machinery used for this purpose was described in our issue of Oct. 26. Practically all the other appliances exhibited possessed no features requiring comment or have been or will be described under other heads. Notable among the latter are the ditchers, scrapers and similar machines which are used in road construction. These will be described separately in another issue.

T-RAILS FOR STREET RAILWAY TRACK.

At the annual meeting of the American Street Railway Association held at Milwaukee, Wis., in October, there was a discussion on this subject, although no report had been prepared by the committee appointed for that purpose. A method of using T-rails with asphalt paving was illustrated and described in our issue of Feb. 23, 1893. The discussion was as follows:

Mr. Burt, Atlanta: This question was fully discussed at the last meeting, yet no satisfactory solution of the best way of paving with T-rail has been offered. We lay the T-rail in our city on a number of the streets, and it has now grown to be the popular rail. The driving in the street is less interfered with by that rail than with any other rail that is laid. We lay the rail on a hard pine stringer, 6 ins. deep, 7 ft. long and 8 ins. wide, and pave clear up to the rail. It makes a very satisfactory foundation and roadbed.

Mr. Hendrie, Detroit: They have done the same thing in Windsor, Ont., using a 56-lb. T-rail placed on chairs with wooden blocks. The block on the outside of the rail is notched at the bottom and sawed off to slant at the top, so that 3 ins. from the rail the top of the block is level with the rail. The street is in very good shape.

Mr. Burke, Terre Haute: We have used brick for paving alongside the T-rail, using a special rail called the Shanghai, 5½ ins. high. Our ties are laid on crushed stone. We are now using a concrete made of the same material with cement, and I think it will give better service. The brick pavement being laid up alongside the rail has proved all right. The paving is kept in excellent condition and is satisfactory to the company. Vehicles go over the track, passing back and forth, inside of it, without any trouble. As to the effect of carriage wheels we have not noticed any deflection or break. We fill the bottom part between the brick and the rail with a concrete of sand and gravel, with cement, for about 2 to 2½ ins. from the flange of the rail, and fill in on top with asphalt. That is what we use on the asphalt street; on the brick street the bricks were made in such shape that it was not necessary to put anything there. Occasionally the dust will give us some bother by filling in the place where the flange of the wheel would run, and will accumulate in such a manner that it retards the progress of our car from the fact that the current had no way of getting to the iron to get back to the station.

Mr. Richardson: The gentleman states that the rail was satisfactory to the company. I should like to know how it was to the public.

Mr. Burke: It was satisfactory in this way: that we were not put to any expense in keeping up repairs on the street that was paved with brick. Other vehicles can use the track, and there have been only two wheels that have come off in crossing the track. In each case the driver admitted that it was his own fault. He tried to turn out too quickly.

Mr. Carr, Roanoke: I would like to say in regard to this question, that I have laid our road with T-rail. I have a little over a mile laid in brick paving. The brick on the outside of the rail was made to conform to the shape of the rail. We use the 56-lb. Pennsylvania rail. We had the brick molded so that it came close to the rail on the inside; but the surface side we had a sort of ogee curve. The ogee curve of the brick makes it very easy to get in and out. We have no trouble, and have not heard any objection from the public. It has been satisfactory to all parties. The only trouble we have had with the brick was where they were not true. In baking them they sometimes get warped, and in such cases they would make trouble. Where we laid our T-rail in macadam it is entirely satisfactory to the public and to the company.

Mr. Burke: The brick is molded in such a manner as to come right up on the outside very near the same height as the rail. The surface is equally hard as in the other parts of the paving. The brick on the inside of the track is molded so as to fit under the head of the rail, and comes up to a natural curvature, and rises on the inside of the rail to an equal height with the paving on the outside of the rail at a point about 1½ ins. from the head of the rail. There is no trouble from the accumulation of dust or of sleet in this space. The cost of the pavement was \$2.32 per sq. yd.

Mr. Hendrie: What the companies are desirous to show is that the T-rail is as good as grooved rail. I think most of the objections which apply to the T-rail will also apply to the grooved rail. The tram head occupies 5 ins., and they have got us down to a grooved rail occupying 4 ins. If we could produce a T-rail which would occupy but 2 ins. and make it easier for wagons to turn in and out, I do not think we would have any trouble on this point.

Mr. Longstreet: A good many years ago I had an idea that the T-rail was the only proper rail to lay in a street, and acting upon that theory I got up a rail which was called the Providence girder rail, which was simply an elongated T-rail without any base. It was 7 ins. deep. It was supported on concrete or ties, and had a cast iron base wedged to it. We laid three miles of that rail in Providence on trial, and it was perfectly satisfactory in every way, and has now become the standard rail of the city. I have also laid this rail in Pawtucket and in Denver. In Denver we have 140 miles of road, and there is nothing there but this Providence rail and the ordinary T-rail.

Mr. Wright, Chicago: In Chicago the municipal authorities require us to furnish 3 ins. of iron for the use of vehicles, while they allow us 2 ins. in width in rail and for the use of the cars. We have educated the vehicles to using our track up to a very great extent. There is one matter that has been lost sight of by the members of the convention, as we have adopted mechanical power for our cars. The amount of power used per car seems to have been considered as of small moment. In the grooved rail, the amount of power used in England, according to Clarke, is from 30 to 60 lbs. per ton. With our flat rail it is from 15 to 30 lbs., whereas on the T-rail, with the exposed head, the cars frequently run with 3 lbs. per ton friction. The old center bearing rail that they used in New York required a comparatively small amount of power, because the head was always kept clear. It seems to me that the T-rail, in paving up to it, will leave a small groove in the pavement, and that this groove will, of necessity fill up with dust and mud in the summer, and ice and snow in the winter to an extent to double the requirements at your power-house in power. In Chicago our traffic is so heavy that Massachusetts granite that has only been down 12 months will show a groove of 1 in. next to the rail. It seems to me that in a city of any great traffic there is no pavement cheaper than the steel for the vehicles that will seek the line of travel. The granite pavement is the most durable that we can find. There are, of course, two sides to the question; and if you are going to lose in the coal pile or in the fodder account, it is poor economy.

Mr. Longstreet: Certainly a large portion of the trouble is due to the fact that we endeavor to get a first-class rail, and pay very little attention to the paving. In most cities now the companies have to pay their proportion for the new paving, and they are giving more attention to the two together in their endeavor to make a first-class roadbed. In Providence there is a narrow street, South Main St., which was laid a number of years ago with the girder rail and granite block pavement, with the interstices filled with peat, gravel and hot tar in the best method. It is a street on which there is a great deal of travel, and I do not think there has been a dollar spent on it since it was laid. We find no trouble whatever. The teams pass over the rail very readily, better than on any other tram rail I ever saw. The roughness of the pavement helps to lift the wheel over.

Mr. Hurt, Atlanta: We are operating about 70 miles of line, and six or eight miles are laid with side bearing rail, section D, Johnson Co., and four miles with Providence girder rail. I regard the latter as the best rail I have seen to pave against. It has no flange on the base, and there is no objection to paving right against it. The only trouble with the rail is in the matter of the joints; you cannot properly fish them. We have made some modifications in the construction to overcome this. The balance of our track, about 60 miles, is laid with T-rail. We think we have successfully met the question in our city.

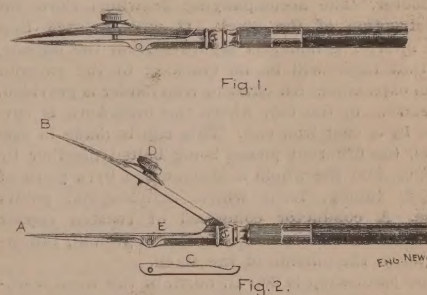
Mr. Heft, Bridgeport: We have had in use seven miles of 56-lb. T-rail for three years, and it has given entire satisfaction both to the city government and to the traveling public. We use the regulation paving blocks between the rails, the inside block being chipped to fit the wheel flange. This construction makes a smooth roadbed and has given better satisfaction than any other type of rail we have used, and we have tried the center bearing, side bearing and

girder rail. I am satisfied that the time is not far distant when all city governments will require street railway companies to lay T-rails in preference to other types.

Mr. Ostrom, Philadelphia: I would move that, when a new committee is appointed on this subject, it be requested to report not only upon the T-rail, but the proper rail to be used for street railway work. There was an effort made at the last convention to approach approximately some standard for street railway work. I do not think it is impossible to standardize rails up to a certain point. Let us find out what is the proper rail to be used, and we shall get it. The great trouble has been that municipal legislation has required a certain form of rail to be used. We should agitate this matter in unison, and present to the authorities arguments and proofs which will convince them which rail should be used. One trouble is that there are too many forms of rail on the market. I appreciate that it is impossible to make one standard rail which will apply to all cities; but it is possible to standardize some parts of the track material, such, for example, as the width of the head. We should have all rails the same size, and the wheels made to conform, so that we will not be chipping the corners of the wheels in running over block or granite pavement.

AN IMPROVED DRAWING PEN.

In our report on the engineering instruments at the World's Exposition, in another column, mention is made of an improved form of drawing pen exhibited by Theodore Alteneder & Sons, of Philadelphia, Pa., which pen is illustrated herewith. The special advantage is in the facility for cleaning the blades, but it seems to offer several others also. A spring, C, acting like the spring of a pocket knife, is inserted in the fixed blade A and pivoted at E, tending to keep the point of the movable blade B in contact with that of A. The set screw D is tapped through the blade B only, and its point bears upon the inner surface of A, its purpose being to spread the blades apart instead of drawing them together as in the ordinary pen. When it is desired to clean the pen the blade B is raised, and is held open by the spring in the position shown by the cut, precisely as a knife blade is held open after it has passed a certain



Alteneder's Improved Drawing Pen.

point. One advantage of this is that when the pen is closed after cleaning the blades are at the same distance apart as before, and do not require to be readjusted for the same thickness of line, the set screw D not having been disturbed, as it must be in the ordinary pen. Under the head of the set screw is a steel spring to increase the friction and prevent the screw from slipping. As the pressure of the spring C is borne by the end of the set screw (the blades being necessarily separated while drawing) there is no liability of pressing the blades together so as to bend the points outward. The instrument appears to us to be a decided improvement in drawing pens, the advantages of which will be apparent to every one accustomed to their use, and the improvement is applicable to compass and bow pens as well as to the ordinary ruling pen.

KNOXVILLE SHOPS OF THE EAST TENNESSEE, VIRGINIA & GEORGIA RY.

Through the courtesy of Mr. C. H. Hudson, General Manager of the East Tennessee, Virginia & Georgia Ry., we are enabled to present herewith a plan of the new repair shops at Knoxville, Tenn., with some of the points of principal interest in connection with them.

The tract on which the shops and yards are laid

out is located about a mile north of the Knoxville station, on the Ohio branch of the system. The yards are laid out on a slight grade, that of the tracks for the bad order cars above the repair shed being about 3-10%, or just enough to have the cars stand without trouble and yet be easily moved. South of the repair shed the grade increases to 1%, so that the cars after being repaired, will easily run away from the shed to tracks prepared for their reception. The breaking-up yard is also on a grade, and is designed to be used as a poling yard for the distribution of the cars.

The shops were planned and located with a view of extending them to the west whenever their capacity becomes inadequate. They can be thus extended 300 or 400 ft. if necessary. The large tract west of the shops will be used at present as a lumber and storage yard.

The machine shop is 100×321 ft., with erecting pits upon one side for 16 engines. The machinery is in the south half of the building. The shops are intended exclusively for repair shops, and not for the construction of new work. The tool-room is adjacent to the office, near the center of the building; the engine and boiler are in the room at the west end, and south of the boiler-room is the brass foundry. Should the shop be extended westward, the engine will then be in the middle. The machinery is driven by a 125-HP. Westinghouse compound engine, the power being transmitted to the two main line shafts by rope driving.

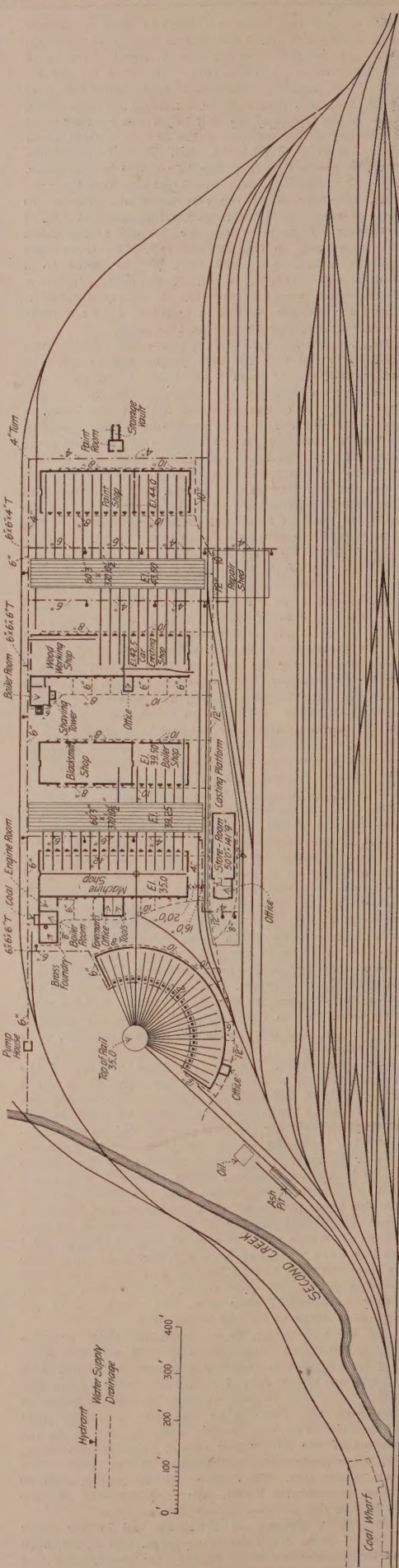
The blacksmith and boiler shop is 90×321 ft. in size, and is located 140 ft. from the machine shop with a 60-ft. transfer table between, moving the whole length of the shops and accessible from tracks at each end. The steam for running the steam hammers, power for the punch, shears and other machinery in this shop is transmitted from the wood-working shop, which is located 140 ft. farther north. This shop is 90×341 ft. in size, with erecting tracks at one end and the office at the center. The engine and boiler-room is at the west end, on the side next to the blacksmith shop.

Adjacent to the boiler-house is the chimney stack, 6 ft. in interior diameter and 120 ft. high. This furnishes draft for these boilers and also for those at the machine shops, the latter connecting with the stack by an underground flue 4 ft. in diameter. The accompanying drawings show the construction of the stack. It will be seen that the interior cylinder is separate from the outside, so that there will be no cracking of the exterior from expansion. An exterior iron ladder is provided, extending to the top, where the brickwork is covered by a cast iron cap. This cap is made in sections, the different pieces being bolted together by flanges, and the whole is surmounted by a piece of copper tubing, from which lightning-rod points arise. A conductor composed of twisted copper wires connects this tubing with the ground, following down the outside of the stack.

The paint shop is 260 ft. north of the wood-working shop. It is 90×321 ft. in size, with 16 tracks, a 60-ft. transfer table being in the separating space between the two shops, accessible, as in the other case, at both ends. Especial care has been taken to fit up this shop for passenger work. Still farther to the north is the paint-mixing room and paint-storing vault. East of the machine shop is the office and storeroom building, with casting platforms at the ends. The office is a handsome two-story building with ample accommodations for the master mechanic and his assistants.

South from all these buildings and about 100 ft. from the machine shop is located the engine-house, 25 stalls of which are finished. When extended to make a complete circle the building will have 60 stalls.

Fig. 2 shows the water supply and drainage systems for the various buildings. A pumping station is located on the bank of the creek, about 200 ft. from the roundhouse, and contains two large steam pumps. These force water into a 6-in. main about 2,000 ft. in length, extending along the west end of the shops for their whole length and thence past the pumping house to a reservoir placed on the top of high bluffs, 1,000 ft. distant. The surface of water in this reservoir is 120 ft. higher than the machine shop floor. The reservoir capacity is 60,000 gallons. For fire purposes, either the water from this tank can be used or a gate in the main leading to it can be closed and a pressure of 150 lbs. can be put on the mains by the pumps.



GENERAL PLAN OF SHOPS AND YARDS OF EAST TENNESSEE, VIRGINIA & GEORGIA RY., AT KNOXVILLE, TENN.

The drawing shows the laterals which branch off from the supply main, and the fire-plugs, which are liberally supplied along the line.

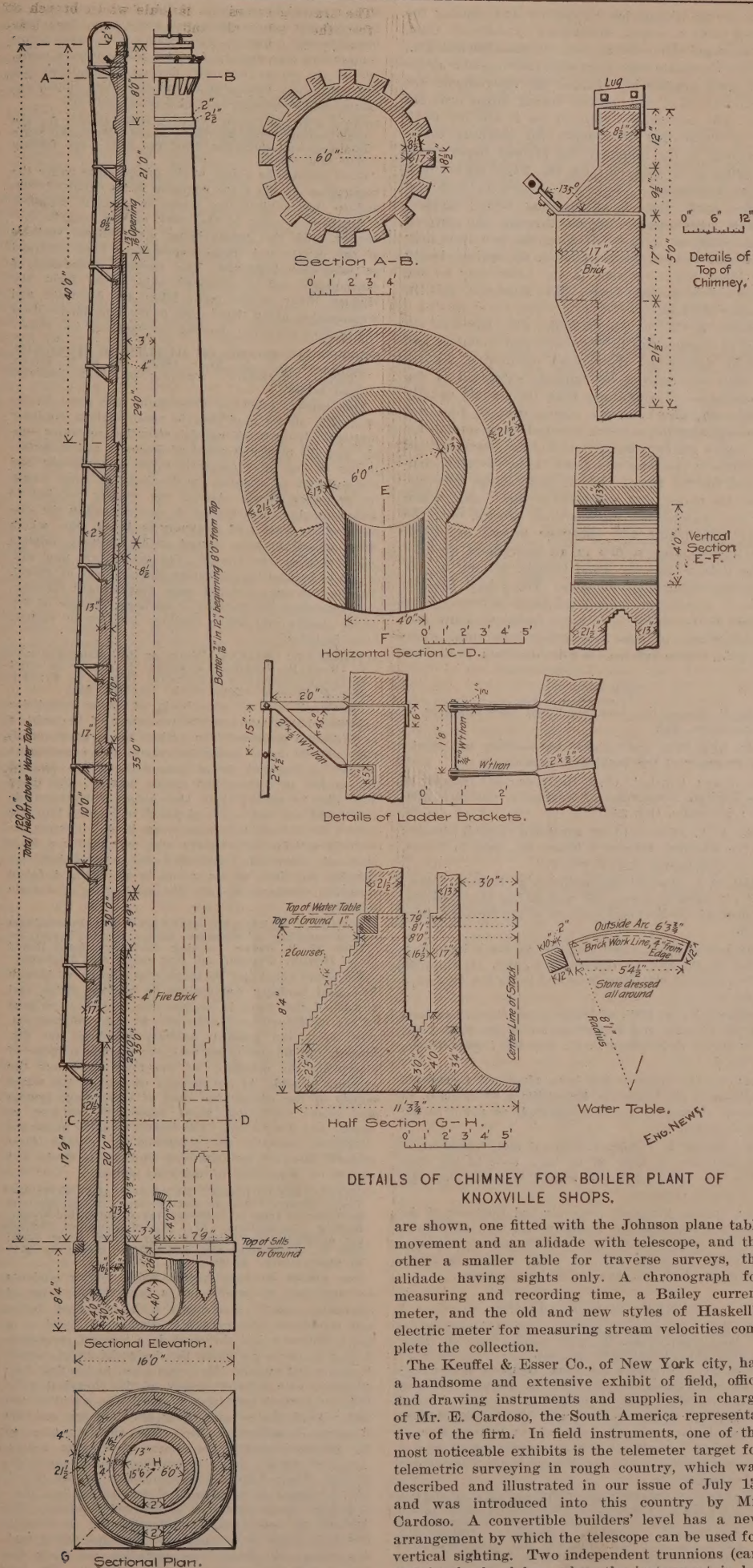
All the buildings are of first-class brick. The roof trusses of all except the engine house are of wood. The engine house roof has a pitch of two horizontal to one vertical, and is supported by double kingpost trusses of 68 ft. span with iron tension members.

ENGINEERING INSTRUMENTS AT THE WORLD'S COLUMBIAN EXPOSITION.

The exhibits of engineers' instruments at the World's Columbian Exposition present very few striking novelties, but include a good showing of standard American instruments by most of the leading makers, as well as special instruments manufactured in the offices of the Coast Survey department. Not all the leading makers, however, have exhibited. The foreign exhibits are small and somewhat scattered, some being on the gallery floor of the Electricity Building, and others on the main floor of the Manufactures Building, while the American exhibits are on the gallery floor of the latter building. It will be seen from our notes that aluminum is not in general favorably regarded for use in field instruments.

The U. S. Coast and Geodetic Survey has several special instruments in its very interesting exhibit. There is an astronomical transit made in 1848, by Troughton & Simms, of London, and reconstructed at the office of the Survey in 1884, and again in 1892. The objective has an aperture of 2.75 ins. and a focus of 45.28 ins. This is the type of transit used in the primary triangulation work of the Survey prior to 1888, when it was superseded by lighter and more modern transits made at the office of the Survey, but as these new transits are now in the field they are represented by photographs only. A repeating theodolite, with telescope pivoted near the eyepiece end, made by Gambey, of Paris, in 1854, has an aperture of 1¼ ins.; a focus of 14 ins.; a circle of 6 ins. diameter, and reads to ten seconds by verniers. The theodolites used in the triangulation work of the Survey are direction instruments with graduated circles from 12 to 24 ins. diameter. The circles are read to a second of arc, or closer, by three or four micrometer microscopes, and the mean of the readings constitutes one observation. In secondary and tertiary triangulation the angles are usually measured with repeating theodolites, with 6-in. to 12-in. circles. Heliotropes (for use on long lines, see Eng. News, March 30, 1893), together with clinometers, odometers, plane tables for ordinary and mountain work (with telescopes on the alidades), and other instruments are also shown. For accurate base line measurements there are shown bars of the multiple bar type for end measuring, the bars being placed end to end successively, and each bar defining the progress of the work until another is adjusted in front of it. In the "iced bar" apparatus the temperature of the bar is controlled by surrounding the bar with melting ice. A bench standard for tapes is also shown. The geodetic level rod used in precise leveling is of + section, and is fitted with a circular disk spirit level, a thermometer, and an endless chain to operate the target. The rod has a brass scale, graduated to centimeters, and is read to tenths of a millimeter by means of a millimeter scale carried by the target. The direction current meter, invented by E. S. Ritchie and E. E. Haskell, is shown in operation. This instrument is to determine the direction and velocity of a current of water, and records these electrically on registers in front of the observer. It has a velocity wheel of the screw or propeller type, conical in front to constitute a self-cleaning prow for all debris moving with the current. The hydrometer, hydrometer cup and hydrophone, used in collecting specimens of water and in determining the relative density thereof, are shown, together with a miniature tide gage in operation.

The U. S. Geological Survey shows a few of the special instruments used in its work, including a theodolite for primary triangulation, and an astronomical transit and zenith instrument combined (made by Fauth & Co., of Washington, D. C.), for determining latitude and time. Two plane tables



DETAILS OF CHIMNEY FOR BOILER PLANT OF KNOXVILLE SHOPS.

are shown, one fitted with the Johnson plane table movement and an alidade with telescope, and the other a smaller table for traverse surveys, the alidade having sights only. A chronograph for measuring and recording time, a Bailey current meter, and the old and new styles of Haskell's electric meter for measuring stream velocities complete the collection.

The Keuffel & Esser Co., of New York city, has a handsome and extensive exhibit of field, office and drawing instruments and supplies, in charge of Mr. E. Cardoso, the South America representative of the firm. In field instruments, one of the most noticeable exhibits is the telemeter target for telemetric surveying in rough country, which was described and illustrated in our issue of July 13, and was introduced into this country by Mr. Cardoso. A convertible builders' level has a new arrangement by which the telescope can be used for vertical sighting. Two independent trunnions (carried in the level box when the instrument is being used in the ordinary way) are screwed into a

collar around the middle of the telescope, the ends of the trunnions resting in the wyes, thus allowing a certain range of vertical movement, which may be as much as 40° above and below the horizontal if the telescope is inverted so as to have the spirit level on top. Another novelty is a steel tape with temperature compensating scale. The tape has a thermometric scale engraved upon it, so that at any known temperature a full corrected measurement of 100 ft. can be made without calculation, the application of the formula for correction being necessary only when a shorter length than 100 ft. is to be measured. In the ordinary line of transits and levels, some improved features have been introduced; the standards have the legs bent into different planes, thus giving greater lateral stability; a new arrangement of adjustable stadia wires is used, by which the adjustment when made is maintained; and the vertical limb is not divided up to its edge, but an overlapping vernier is used, and is hinged so that it can be thrown back out of contact with the limb. For office work there is shown the eidograph, a modified and cheap form of pantograph for enlarging and reducing drawings. In regard to the use of aluminum for field instruments, the firm state that they have used it to some extent and are prepared to use it when specially called for, but it is not recommended, as it is not considered a suitable metal for instruments of precision. The exhibit includes an aluminum transit, but the divisions on the aluminum are practically invisible. Too great lightness in the instrument results in serious vibration. The Keuffel & Esser Co. is also agent for C. Bube, of Hanover, Germany, who has an exhibit of steel tapes, etc.

W. & L. E. Gurley, of Troy, N. Y., exhibit a number of transits, ranging from the more elaborate solar transits (some fitted with the Jones patent latitude arc) to the simpler and lighter reconnaissance and mountain transits. The transit with 5-in. needle is considered as the standard for railway purposes. In leveling instruments there are wye, architect's and drainage levels, the latter being simple and compact, with level and telescope inclosed in a bronze case. Plane tables are shown, and three styles of alidades for use with the plane table, suitable for various grades of work; one has sights only, and the others have telescopes. The traverse plane table is very simple and is used extensively by the U. S. Geological Survey for traverse work. Several styles of compasses are shown, including the dip compass, with needle moving in a vertical plane; a pocket compass of aluminum, which is useful for topographical work; and a clinometer compass. Level rods, targets and the Abney and binocular hand levels are among the exhibits, together with an adjustable plumb-bob, in which the cord, when not in use, is wound around an inner reel by turning the cap. Among the special instruments exhibited are the Price current meter, illustrated and described in our issue of March 2, and the Boyden hook gage for determining the precise depth of water flowing over weirs, the scale being read by verniers to thousandths of a foot. As to the use of aluminum, this firm has made a number of such instruments, and is prepared to make to order any instrument of regular pattern, but the demand is found to be quite limited, as nearly everybody prefers the regular brass and bronze.

Buff & Berger, of Boston, Mass., show a number of transits, ranging from 8-in. and 7-in. transits for triangulation to a small engineer's transit weighing only 10 1/2 lbs.; they also include mining and surveyors' transits with solar attachments, and reconnaissance transits, some fitted with stadia wires. The patent universal mining transit, with duplex telescope bearings, has its standard frame, vertical circle and striding level made of aluminum. A tachymeter, or transit fitted with stadia wires, is also shown. The exhibit includes dumpy and wye levels and an engineers' precise level with mirror and one fixed and one striding level, and fitted with a micrometer screw for the close setting of the spirit level bubble. Two tripods are shown, one extension and one regular, as supplied with the more portable instruments. The plane table alidade shown has fixed stadia wires and a detached compass, and the striding level and ruler are of aluminum. The exhibit also includes Locke's hand level, interchangeable lamp targets for mining

transits, plumb-bobs, targets, tapes, etc. Two electric current meters are shown: the Ellis meter for use in rivers, harbors, etc., and the Fteley & Stearns meter for measuring the velocities of currents in conduits, flumes and shallow rivers. The firm states that aluminum and its alloys may be, and to some extent are, used for telescope standards, tripod heads, vertical circles and other parts, but as yet there is little demand for the material, and it is considered that its use in fine instruments will always be limited owing to the fact that the metal is very soft, although rigid, and becomes brittle when alloyed with copper to make it harder. An alloy of 95% aluminum to 5% silver gives good results, but is expensive, and little is gained in reduction of weight by the use of aluminum bronze, which has 10% aluminum to 90% copper. Where light weight is of importance the firm recommends its smaller transits in preference to larger instruments made in whole or in part of aluminum and of equal weight, as the former retain their adjustments better than the latter, while being equally as durable and capable of doing just as close work.

Young & Sons, of Philadelphia, Pa., exhibit several of their standard makes of instruments, selected from stock and having no especially novel features. Three interesting instruments may be noted, as follows: 1, the first American transit, invented in 1831 by W. J. Young, and made in 1832, which instrument has been in use for 50 years; 2, a serviceable transit used on the Intercontinental Railway survey, on the section between Quito, in Ecuador, and Cuzco, in Peru (Eng. News, Jan. 26 and June 29, 1893), with which transit and stadia lines have been run aggregating 1,700 miles in length; and, 3, a level exhibited at the Centennial exhibition at Philadelphia, in 1876, which has been in constant use since that time and is still a good instrument. Among the minor appliances for field work are the cup-headed stake tacks illustrated in our issue of Jan. 26, 1889. In regard to the use of aluminum, this firm states that it has not had many calls for instruments to be made of it, and that experience has shown that it is not satisfactory for surveying instruments to be made entirely of this metal. The weight of a transit or level can be reduced 20 or 25% by making certain parts of aluminum, but further than this the firm does not care to use the material.

F. Weber & Co., of Philadelphia, Pa., have exhibits of instruments by foreign makers for which they have the agency, and many of which are carried in stock. The instruments of Albert Ott, Kempton, Bavaria, include tachymeters for surveying and stadia work; planimeters; an elaborately constructed pantograph for accurate reduction and enlargement of drawings up to a proportion of 1 to 20; current meters with electrical connections to the counter (two of these have been constructed under the direction of Professor Harlacher, of Prague); and plane tables and stadia poles. The instruments of Sigmund Riefler, of Munich, include various lines of drawing instruments, and some very delicate clockwork attachments for astronomical work. His astronomical clock is said to have the greatest precision yet attained for any mechanical movement, and the attachments have also been applied to tower clocks. His special exhibits in this line are a mercurial compensation pendulum, and a pendulum escapement with free pendulum, the impulse being communicated in the axis of oscillation and at the moment in which the pendulum swings through the dead point. The exhibits of A. Schoenner, of Nuremberg, are drawing instruments. As to the use of aluminum for field instruments, Weber & Co. state that they learn that the metal has hardly been used yet for such instruments, the objection being that it is too light and wears quicker than the other metals now in use.

The Eugene Dietgen Co., of Chicago, Ill., has an exhibit of Swiss drawing instruments by Kern & Co., of Aarau, and it is claimed that while there is nothing specially novel in this exhibit, the styles have been improved, and the instruments are light and of good workmanship and finish. Besides this exhibit in the Manufactures Building, the Dietgen company has in the Mining Building an exhibit of L. & C. Hardtmuth's drawing pencils, made with graphite of smooth and even quality which by a new process of manufacture is highly compressed,

thus giving it good lasting quality and causing the pencil point to remain sharp for a considerable time.

Theodore Alteneder & Sons, of Philadelphia, Pa., have a showcase full of drawing instruments, scales and office appliances. Among the instruments are specimens of a new patent spring hinge drawing pen. The advantages claimed for it are the facility of separating the blades for cleaning them. A spring in the hinge of the pivoted blade tends to bring it in contact with the fixed blade. The usual thumbscrew, therefore, is used to keep the blades apart instead of bringing them together, and is consequently tapped through the pivoted blade only, so that in cleaning the pen it is only necessary to open them by hand, the spring closing the blade when released in the same way as the blade of a pocket knife. We illustrate this in another column.

Queen & Co., of Philadelphia, Pa., have an exhibit of engineering instruments, and chemical and optical apparatus. The most distinctive feature of their engineering instruments exhibited is the combination of aluminum with the metals usually employed. The company states that it does not consider aluminum to be a satisfactory metal for the entire instrument, as it is bad for bearings, and is brittle in the form of screws. It is, therefore, employed for the heavier parts, such as the telescope tube, the plates, and standards of the transit, while for the centers, bearing surfaces, screws, etc., the usual gun metal and phosphor bronze are used. The combination results in an instrument about a third lighter than the usual transit, without in any way sacrificing the efficiency. The tripod head is also of aluminum, with hard brass screws. It is stated that careful tests have failed to show any disadvantage in thus employing aluminum, while the gain, where lightness is a desideratum, is obvious.

PERSONALS.

Mr. E. Brown has been appointed City Engineer of Indianapolis, Ind.

Mr. John Fritz has resigned his position as Consulting Engineer of the Bethlehem Iron Co.

Professor Grashof, Civil Engineer, and Director of the German Association of Engineers, died at Carlsruhe, Germany, Oct. 26.

Mr. A. A. Allen has been appointed General Manager of the Missouri, Kansas & Texas Ry. lines in Texas, with headquarters in Denison, Tex.

Maj. E. S. Hosford died suddenly at Jackson, Tenn., Oct. 19, aged 53 years. He was at one time Superintendent of the Northern Division of the Mobile & Ohio R. R.

Mr. Louis Giraud, Chief Engineer of the Velasco Terminal R. R., died at Velasco, Tex., Oct. 11, from injuries received in falling from and being run over by a hand car.

Judge John M. Hall, of Willimantic, Conn., has been elected Director and Vice-President of the New York, New Haven & Hartford R. R., vice Mr. Lucius Tuttle, resigned.

Mr. G. H. Sharman has been appointed Consulting Engineer of the Louisville, Evansville & St. Louis R. R. Several extensions are contemplated, as noted in another column.

Mr. Robert B. Campbell, General Superintendent of the Baltimore & Ohio R. R. lines west of the Ohio River, has been appointed General Manager, vice Mr. J. T. Odell, resigned.

Mr. Vassily Strelkoff, Inspector and Engineer of the seventh division of the transcaucasus Ry., of Russia, and Mr. Joseph Kozlowsky, Superintendent of Motive Power of the same road, are in this country to investigate American railways and railway practice.

NEW PUBLICATIONS.

REPORT OF THE ILLINOIS STATE RAILROAD COMMISSION for the year ending June 30, 1892. Pub. Doc.; 80vo; cloth; pp. 331.

This report contains the usual complete tables covering the various branches of the railway business during the year, and the details of the operations of the several railways in the state. The feature of chief technical interest is the report of Mr. Charles Hansel, the former Consulting Engineer of the board, on the use of "Railway Safety Appliances in the Kingdom of Great Britain."

ADDRESSES DELIVERED BEFORE THE WORLD'S RAILWAY COMMERCE CONGRESS, Held in Chicago, Ill., June 19, 23, 1893, Under the Auspices of the World's Columbian Exposition. Official Report. Chicago: "The Railway Age and Northwestern Railroaders." 8vo; cloth; pp. 265; \$3.

The proceedings of the Railway Commerce Congress

were reported in our issue of July 6, and abstracts of some of the papers presented there have been published in our columns. The volume now under notice contains an introductory account, the addresses made, and all the papers presented, dealing with railway law and legislation, management and operation, employees, history and development, and foreign railways.

STATE ENGINEER OF NEW YORK: Report for the year ending Sept. 30, 1892. Martin Schenck, State Engineer and Surveyor. 8vo; pp. 328; large folding map and plates.

Chief among the public works of the state under the supervision of the state engineer is its canal system, and to that subject this report is largely confined. A detailed account of the work of the year in connection with the canals being given. Some sections of the canals and their feeders have been enlarged or otherwise improved. The electric propulsion of canal-boats and a proposed ship canal from the Hudson River to the great lakes are discussed and investigation along these lines is recommended. Maps and profiles are given showing the canals of the state.

PROVINCIAL BOARD OF HEALTH OF TORONTO. Report for the Year 1892. Dr. P. H. Bryce, Toronto, Secretary. Pamph.; pp. 137; diagrams and tables.

This report, including those from the local boards of health, shows that Ontario ranks high in sanitary matters, giving much careful attention to water supply and the proper disposal of domestic and manufacturing wastes. The economic value of sanitation and the pollution of streams are discussed at some length by Secretary Bryce. Among the reports relating to water supply and sewerage is one regarding the disposal of the wastes of a tannery in Acton, Ont., which were alleged to have caused anthrax among animals pastured along the stream. The wastes are now subjected to intermittent filtration through beds of gravel. The local reports contain some fragmentary information regarding the disposal of garbage, the use of dry earth closets and other sanitary matters in various municipalities.

HYDRAULIC CEMENT.—Notes on its testing and use. By Fred P. Spalding, Assistant Professor of Civil Engineering, Cornell University. Ithaca, N. Y.: Andrus & Church. 12mo; cloth; pp. 108. \$1.

The small size of this book, of course, precludes anything but a mere outline treatment of the subject of hydraulic cements. The author has a good knowledge of the most recent literature and experiments on the testing and use of cements, and has handled the subject in a clear and simple manner. For those who like to obtain their knowledge in homeopathic doses and are not much disposed to inquire into the reason for things, the book seems likely to prove extremely satisfactory. Others who may prefer a more thorough knowledge will find the book helpful in pointing out lines of study and in providing a fairly complete bibliography of the subject of hydraulic cements.

MICHIGAN SANITARY CONVENTION: Proceedings of a meeting at Stanton, Mich., April 27 and 28, 1893. H. B. Baker, Lansing, Secretary State Board of Health. Pamph.; pp. 118; charts and diagrams.

For some years the Michigan State Board of Health has held sanitary conventions in various cities and towns of the state in conjunction with the citizens of the municipalities concerned. At these conventions, both local and general sanitary problems are discussed, the former often with the specific purpose of improving the condition of the town in which the meeting is held. At the Stanton convention the water supply of the village, the need of a sewerage system and school sanitation were made the subject of papers and discussions. The report contains numerous diagrams showing the reduction of deaths from zymotic diseases by improved sanitary methods and papers on a number of different subjects.

CONTINUOUS CURRENT DYNAMOS AND MOTORS: Their Theory, Design and Testing. With sections on Indicator Diagrams, Properties of Saturated Steam, Belting Calculations, Etc. An elementary treatise for students. By Frank P. Cox, B. S. New York: The W. J. Johnston Co., Ltd.; 12mo; cloth; pp. 271; \$3 illustrations. \$2.00.

The author in placing this work before students assumes that the reader has a general knowledge of electricity and is conversant with electrical terms and machinery. No particular machine is used as a basis, however, but the work is a general consideration of the laws governing the design of direct-current dynamos and motors. He commences, in the first four chapters, with a brief review of the electrical units and the general principles of machines, avoiding the higher mathematics and using only algebra and the elements of geometry. Succeeding chapters treat of the magnetic circuit; the theory of winding, losses, etc., and special points to be observed in motor designing. Then follows the application of the principles developed to the design of armatures, field magnets and motors, explained by selected problems. The methods of testing and investigating the characteristics and effects of a completed machine, under various changes in design and operation, are fully discussed and illustrated by curve diagrams. The last

two chapters are devoted to indicator diagrams and steam power calculations, and the four appendices contain tests of iron, ampere-turntables, determination of size of wire for armatures and field-coils and calculations of belting.

SPECIAL ASSESSMENTS: A Study in Municipal Finance. By Victor Rosewater, Ph. D., University Fellow in Political Science. Vol. II, No. 3, of "Studies in History, Economics and Public Law," Edited by the University Faculty of Political Science of Columbia College, New York; Columbia College. Pamph.; pp. 152; 75 cts.

This excellent monograph reviews the history of special assessments both abroad and in this country and discusses the law and theory of the subject. By special assessments, as is generally known, is meant those charges levied against real estate for public improvements which distinctly benefit the property assessed, as street improvements and sewers. In nearly all the states of the Union this method of paying for local improvements has been or is practiced, and in most of the states the legality of the principles involved has been settled by the courts. The study has been very carefully made, is supplemented by a bibliography and a list of legal cases, and may be read with profit by all who have to do with devising means to pay for the class of public improvements discussed or who are interested in this phase of public finance.

THE LEMNISCATA AS A TRANSITION CURVE.—By B. S. M. Lovelace (54 St. Matthew St., Montreal). Assoc. M. Can. Soc. C. E. 12mo; pamph.; pp. 26. Published by the Author. 30 cts.

This is well worth its price to any one interested in transition curves. Its general arrangement and scheme is good. The name of the curve has heretofore been unknown to us, but the curve itself is all right. It gives a proper transition curve, with the one fatal objection that, as presented by the author, the curve does not readily admit of using more than one length and offset with any given degree of curve. Moreover, the author has quite unnecessarily given the offset at the P. C. in such form that its value can only be determined by subtracting the radius from it. This involves wholly unnecessary work. It should have been given with the radius already subtracted.

In the "special cases" which the author recognizes as possible (really they are the more common cases in good location, and almost universal in rough country) when some irregular length and offset is required, the author does not seem to recognize that it is almost always the offset which is given or which must be assumed, regardless of what length results, but proceeds instead to assume that it is the length and not the offset which will be the given quantity. This was not essential and is unwise. The author could and should give some tables to facilitate the use of any length and offset with any degree of curve.

By getting out a new edition revised from this point of view the author might greatly increase the usefulness of his work. In the meantime any method is better than none, and this little pamphlet gives a very simple one, easily understood and clearly stated, if not very flexible.

UNIVERSAL Bimetallism, and an International Monetary Clearing House; together with a Record of the World's Money, Statistics of Gold and Silver, etc. By Richard P. Rothwell, M. E., C. E., Editor Engineering and Mining Journal, Etc. New York. The Scientific Publishing Co. 8vo, pp. 53; 75 cts.

This work is, as all such works should be, largely devoted to facts, and only to a limited extent to theory. Almost every fact of importance bearing upon the problem discussed will be found recorded here, and merely as a book of reference the work is of great value to all those interested in its subject.

Mr. Rothwell's recommendations are in brief that an "International Monetary Clearing House" should be established by joint action of civilized nations, to which in substance the ordinary law-making bodies are to delegate their authority, to establish a universal monetary standard, and to regulate and control it. This he advocates on the ground that experience justifies the belief that such a "body of experts" would arrive at a wiser and juster solution of the problem than "the more or less biased legislators of any one country." Perhaps they would, but we do not think it at all probable that the "legislators of any one country" will take that view of the case, nor do we recall any historical evidence that such wisdom is likely to develop in any such gathering of "experts" as to make it wise to delegate to it any legislative authority. We fear, therefore, that Mr. Rothwell's plan is impracticable for this reason alone. Partly because of this, and partly because it is impossible to do full justice to another man's concisely stated proposition without stating it in his own words, and partly because it is outside of the legitimate scope of this journal to enter into detailed discussion of financial technicalities, we do not attempt to summarize this plan more fully. As a storehouse of facts, however, from which any one can draw conclusions to suit himself, we can safely commend the book to any one interested in its subject, while its theories are at least deserving of respectful study.

SOCIETY PROCEEDINGS.

NORTHWEST RAILROAD CLUB.—At the annual meeting on Oct. 24 the following officers were elected: President, J. C. Barber; Vice-Presidents, E. A. Williams, G. D. Brooke; Treasurer, J. O. Pattee; Secretary, C. A. Seely.

CENTRAL RAILWAY CLUB.—At the meeting on Oct. 25 Mr. Jas. Howard read a paper on brake rigging. He found fault with the use of automatic slack adjusters, claiming that they were likely to clamp the brake rigging and prevent the push rod from following the piston back when the brakes were released. If this occurs the piston will strike the push rod a hard blow when an emergency application of the brakes is made, and a hole is liable to be punched through the piston.

WESTERN RAILWAY CLUB.—At the October meeting a paper was presented by Mr. George Gibbs (Chicago, Milwaukee & St. Paul Ry.) on "Passenger Train Equipment at the Columbian Exposition." The paper described the several American and foreign passenger cars, but most of the information has already been given in our issues of Sept. 28 and Oct. 12. While commending the many admirable features in construction, Mr. Gibbs noted the excessive decoration and the small carrying capacity of some of the American cars, which we have also criticized, and he also objected to the wide vestibules, considering it bad practice to encourage passages to use the platforms or vestibules as lounging places.

ENGINEERS' CLUB OF PHILADELPHIA.—At the meeting on Oct. 7, President John Birkinbine described the exhibit of Fried. Krupp, of Essen, at the World's Fair, and Lieut. William H. Jaques explained and illustrated by lantern slides the exhibits of the Bethlehem Iron Co. at Chicago. Both these exhibits have already been described in this journal.

At the meeting on Oct. 21, 46 members and visitors were present, considerable business was transacted and Mr. John C. Trautwine, Jr., read a paper on the exhibits of the Pennsylvania R. Co. at the World's Fair. Mr. Birkinbine described the movable sidewalk at the same place, and also explained a photograph of the pyramid, in the Mines and Mining Building, made up of cubes representing the relative volume of different minerals produced in the United States in one second. The pyramid was illustrated in our issue of Oct. 12.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.—At the meeting at Pittsburg, on Oct. 17, a paper on "Natural Filtration for Domestic Water Supply" was read by Mr. G. Kaufman, in which the idea was presented that the city could secure a sufficient supply of good water by driving galleries parallel with the bed of the Allegheny River, and securing the underground water which he thinks feeds that stream. He proposed the use of wooden flumes 15 ft. wide and 4 ft. deep, sunk in trenches across the bed of the river and having their ends connected with the underground galleries. Mr. Metcalf said that a similar plan had been tried at Etna, Pa., in 1878, where cribs 10 x 10 ft. were built, the top of the filtering material being level with the bottom of the river. He considered that there was no ground water, the crib taking its supply from the river. Colonel Roberts said that ice would disturb the flumes and galleries. A paper by Mr. Wickersham on the use of sand in extinguishing large fires where oil in tanks had been fired by lightning was read by Colonel Roberts.

At the meeting of the Chemical Section on Oct. 24 a paper was read by Dr. Charles B. Dudley, chemist of the Pennsylvania R. R., on "The Necessity for Standard Methods of Analysis of Iron and Steel." The following is an outline of its substance:

When reputable chemists analyze identical samples with pure chemicals, and disagree, the fault must be one of method. The adoption of standard methods would enable competent chemists to obtain strictly comparable results. Such methods would be revised when necessary, but should be regularly used until so revised.

The work of the committee on international standards for the analysis of iron and steel will produce valuable results. Their standards, however, will not be a check on difference of methods of analysis. A method of analysis may have reciprocating errors and give correct results on samples of one certain composition only. A chemist using such a method might agree with the standard sample and be wrong on all samples of different composition.

A further shortcoming of standard samples as checks on methods of analysis is found in the following consideration. Unless the standard contains carbon, etc., in exactly the same state of combination in the steel in which it exists in all other samples analyzed by same method, it is not a check on the correctness of the method.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—At the meeting on Sept. 21 the first subject

discussed was the effect of overpressure on brake-shoes in causing hot boxes. Several members reported experience which showed that hot boxes had been caused by engineers running up the trainpipe pressures far beyond the standard of 70 lbs. per sq. in. This caused the brake shoe to press against the wheel with such force as to throw the journal to one side under the edge of the brass. Mr. R. P. C. Sanderson, of the Norfolk & Western, presented a paper on the proportioning of balanced slide valves. He showed that for a Norfolk & Western consolidation locomotive the pressure on an unbalanced valve is from 22,000 to 23,000 lbs., the steam chest pressure being 135 lbs. per sq. in. For a fast passenger engine on the same road the valve-seat pressures are 23,200 to 26,900 lbs. If a minimum downward pressure of 500 lbs. be allowed to keep the valve from lifting, then about 155 sq. ins. of the top of the valve could be safely balanced. In actual practice the area balanced is only 110 sq. ins., and it is queried whether a larger area might not be balanced with beneficial effect. Mr. Sanderson also quoted an experiment in which an unbalanced slide-valve of a 9 x 12 in. stationary engine was found to absorb 7% of the total power developed. A balanced valve was substituted and only absorbed 1.1% of the engine's power.

The next subject discussed was the use of relief valves on steam chests. Some objection was made to relief valves, the claim being made that on dusty roads they admitted dirt and grit to the valve seats when air was sucked through them. One member also thought that cracked bridges between the ports might be due to the admission of cold air through the relief valve. Most of the members favored relief valves, however, and thought it better to run the chances of dust from outside than to draw cinders from the smokebox down the exhaust pipe. The placing of brake shoes in front or behind drivers was then discussed, but the only information elicited was from Mr. A. G. Smart, who puts the shoes on top of the wheel.

The next meeting will be held on Nov. 16. Copies of the full proceedings can be obtained from Mr. S. A. Charpiot, Secretary, Macon, Ga.

COMING TECHNICAL MEETINGS.

ENGINEERS' CLUB OF PHILADELPHIA.

Nov. 4. Secy., L. F. Rondinella, 1122 Girard St.

SWEDISH ENGINEERS' CLUB.

Nov. 4. Secy., P. Valentine, At 281 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago

CIVIL ENGINEERS' SOCIETY OF ST. PAUL.

Nov. 6. Secy., C. L. Anna, City Engineer's Office.

ENGINEERS' SOCIETY OF PHOENIXVILLE.

Nov. 7. Secy., W. Halliburton.

NEW ENGLAND RAILROAD CLUB.

Nov. 8. Secy., F. M. Curtis, P. O. Box 1576, Boston.

WESTERN SOCIETY OF ENGINEERS.

Nov. 8. Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.

ENGINEERS' CLUB OF MINNEAPOLIS.

Nov. 9. Secy., E. Nexsen, 504 Kasota Block.

CANADIAN SOCIETY OF CIVIL ENGINEERS.

Nov. 9. Secy., C. H. McLeod, Montreal, P. Q.

ENGINEERING ASSOCIATION OF THE SOUTH.

Nov. 9. Secy., W. G. Kirkpatrick, Nashville, Tenn.

ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.

Nov. 9. Secy., F. W. Mowbray, Norton Building.

NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.

Nov. 10. Secy., D. W. Meeker, St. Paul.

ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.

Nov. 10. Secy., E. K. Smoot, 608 Commerce St.

TECHNICAL SOCIETY OF THE PACIFIC COAST.

Nov. 10. Secy., O. Von Geldern, 719 Market St., San Francisco.

MONTANA SOCIETY OF CIVIL ENGINEERS.

Nov. 11. Secy., G. O. Foss, Helena.

ENGINEERS' CLUB OF KANSAS CITY.

Nov. 13. Secy., Waterman Stone, Baird Building.

DENVER SOCIETY OF CIVIL ENGINEERS.

Nov. 13. Secy., F. E. King, Jacobson Block.

WISCONSIN POLYTECHNIC SOCIETY.

Nov. 13. Secy., M. F. Schinke, City Hall.

CIVIL ENGINEERS' CLUB OF CLEVELAND.

Nov. 14. Secy., F. C. Osborn, Case Library Bldg.

NORTHWEST RAILROAD CLUB.

Nov. 14. Secy., W. D. Crossman, Ryan Hotel, St. Paul.

NORTHWESTERN SOCIETY OF ENGINEERS.

Nov. 14. Secy., D. W. McMorris, Burke Block, Seattle, Wash.

ASSOCIATION OF ENGINEERS OF VIRGINIA.

Nov. 15. Secy., L. J. Carmalt, Roanoke, Va.

ENGINEERS' CLUB OF ST. LOUIS.

Nov. 15. Secy., Arthur Thacher, Odd Fellows' Building.

AMERICAN SOCIETY OF CIVIL ENGINEERS.

Nov. 15. Secy., F. Collingwood, 127 East 28th St., New York.

CIVIL ENGINEERS' ASSOCIATION OF KANSAS.

Nov. 15. Wichita, Kan.

BOSTON SOCIETY OF CIVIL ENGINEERS.

Nov. 15. Secy., E. E. Tinkham, 36 Broomfield St.

ASSOCIATION OF ENGINEERS OF VIRGINIA.

Nov. 15. Secy., L. V. Carmalt, Roanoke, Va.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.

Nov. 16. Secy., S. A. Charpiot, Macon, Ga.

NEW YORK RAILROAD CLUB.

Nov. 16. Annual meeting. Secy., John A. Hill, Temple Court, New York.

ENGINEERS' CLUB OF CINCINNATI.

Nov. 16. Secy., J. F. Wilson, 24 W. 4th St.

SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.

Nov. 16. Secy., Allen Strale, 100 Washington St.

TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS.

Nov. 17. 201 Washington Building.

WESTERN RAILWAY CLUB.

Nov. 21. Secy., Clement F. Street, Chicago.

COLUMBIAN ENGINEERING SOCIETY.

Nov. 21. Secy., F. W. Hart, Washington, D. C.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.

Nov. 21. Secy., R. H. Clark, Pittsburg.

CENTRAL RAILWAY CLUB.

Nov. 22. Secy., S. W. Spear, Buffalo, N. Y.

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AND

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After the many words of condemnation regarding the quality of the water supply of Chicago, it is a pleasure to record, as is done in another column, testimony to the effect that the quality of the water supply of that city has been greatly improved by the extension of the intake tunnels. It is true that almost the sole reasons for stating that the water supply has been greatly improved are the reduced typhoid fever mortality of the city and the assumption that no other results could follow the drawing of water from points farther out in the lake and less liable to contamination. Detailed figures, given elsewhere, show that according to the mortality records of the city the number of deaths from typhoid fever for the year ending Sept. 30, 1893, was only 712, against 1,790 for the preceding year, a reduction of nearly 60% in the number of deaths from this disease. The percentage of typhoid to total deaths for 1893 also shows about the same reduction, the percentages having been 6.72 and 2.64. Moreover, the records show that the reduction was distributed throughout the whole city. It is stated that during the first two months of the latter year, water from the old intakes was largely used and also that during the first year improvements were made in a part of the supply, which has doubtless somewhat lessened the contrast between the two years.

A few points not brought out in the paper may be mentioned: There has not been, so far as we can learn, in 1892-3, such vast quantities of pollution carried into the lake from the Chicago River and its branches as was the case in 1891-2, because no such freshets occurred during the year past. While this fact tends to emphasize the improvement in the supply, it shows that this improvement may not be wholly due to drawing water farther from the shore.

Doubtless the general sanitary condition of Chicago, aside from its water supply, was better in 1892-3 than in 1891-2, on account of the fact that general attention was called to the typhoid mortality, the effect of the cholera scare, shared by Chicago in common with other cities, and the desire to have the city in good sanitary condition during the Fair. The purification of the sewage and the burning of the garbage from the Exposition have doubtless had some effect upon the health of the city. Most important of all, the provision within the Exposition of filtered and sterilized drinking water, and of water piped from Wisconsin, and the further fact that many people avoided drinking ordinary

Chicago water when off the grounds, doubtless had a great effect in keeping down the typhoid mortality among the visitors at the Fair. These visitors, the authors of the paper state, like all people who drink water to which they are unaccustomed, were especially liable to any infection which it might convey; and Philadelphia during the Centennial is cited as proof. But there was no attempt to furnish pure water at Philadelphia, and the people who went there had no such warning against impure water as was given by the press of the whole country to intending visitors to Chicago.

A simple phrase which catches the popular ear may have much to do in molding public opinion and furthering important reforms. Nobody knows what newspaper writer coined the phrase "the deadly car stove"; but whoever it was did, perhaps, as great a work in bringing about the abolition of the stove and the application of steam heating to passenger trains as was done by any other one man. It is about time that some other unknown benefactor coined the phrase "the deadly flywheel," and gave it currency.

Within the last year a half dozen serious breakdowns of large engines have occurred, and those causing greatest fatalities and damage have been due to the failure of the flywheel. It is noticeable that most of these flywheel accidents have occurred in the power-houses of electric street railways, where the load on the engine is subject to greater and more sudden variations than in almost any other service. Concerning one of these recent failures, that in the central station of the Memphis Light & Power Co., a contemporary said:

The event seems properly classed among the many singular and inexplicable accidents in which blame cannot be justly placed on anyone, and which human foresight seems incapable of anticipating and preventing.

This appears to be stating the case pretty strongly. A fairer and more correct statement would be that engine builders continue to make flywheels which will occasionally break, simply because most engine buyers do not wish to pay for better and safer ones, but consider cast iron wheels as on the whole safe enough. To say that human foresight and ingenuity is incapable of making a flywheel of any better and safer material than cast iron, is to ignore the fact that flywheels have in special cases been constructed of other materials to obtain a higher factor of safety. The most notable case is probably the wooden rim flywheel* built by Mr. Chas. H. Manning for the Amoskeag mills, at Manchester, N. H., after a very costly experience of the unreliability of a cast iron wheel. Mr. Manning claims that this wooden rim wheel has a factor of safety ten times as great as that of a sound cast iron wheel; and that instead of being more expensive than the cast iron wheel it actually cost less.

Another example of the use of better material than cast iron for flywheels is found at the Mannesmann Tube Works, in Germany and Wales. The flywheels used on the Mannesmann rolling mills have to store a large amount of power, and are run at excessively high speed. The rim of the wheel is of wire wound in a continuous coil, and the wheel can be run with perfect safety at velocities which would scatter a cast iron wheel into innumerable fragments.

There are doubtless other examples; but these will serve as illustrations of the fact that stronger and more reliable materials can replace cast iron when the engine user thinks it worth while to call for them. But it is not even necessary to replace cast iron to make a great improvement in many flywheels. Better design for castings, to prevent dangerous shrinkage strains, and better design in the fastenings of built-up wheels could do much to guard against failures, and with no great increase of expense. Racing is always possible on any engine; and every flywheel ought to be made with such a large factor of safety that the engine can race up to a reasonable excess of speed without overstraining the wheel in any part.

We give considerable space this week to a paper describing an application of the storage battery to secure better economy in the operation of electric

*Engineering News, April 28, May 19, 1892. Trans. Am. Soc. M. E., Vol. XII., p. 618.

light and power stations. This is a practice which has already been extensively adopted in Europe, but in which only a beginning has been made in this country. On the European continent fuel economy is looked after far more sharply than here, and any improvement which promises a saving in the coal pile, even at the expense of some additional complexity, is taken up at once. The extended use of the storage battery in European stations is pretty good evidence that it is a commercial as well as mechanical success there. Of course, it does not follow that it would necessarily be a commercial success here. In fact, where coal is as cheap as it is in many parts of this country, there is probably little chance that the storage battery could make any saving. On the other hand, where fuel is expensive, as it is in New England, and in many parts of the West and South, managers of central electric stations would apparently find it well worth while to investigate the storage battery question.

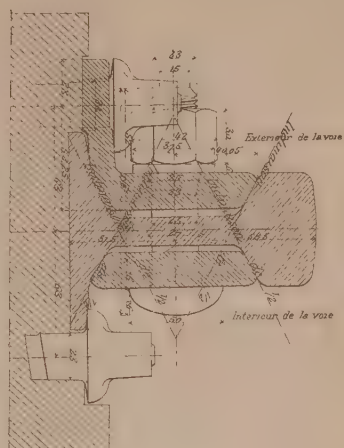
As stated in Mr. Mailloux's paper, the Edison Electric Illuminating Co., of New York city, has had in use for some months a large storage battery of the Crompton-Howell pattern at one of its uptown stations, and it has given very satisfactory results.

One reason why the storage battery in this country has been slow to find general favor is that American inventors have concentrated their energies on making the storage battery available for street car propulsion, and have been beaten at every point by the electric trolley system in the contest for commercial supremacy. To make a storage battery which could be used on a street car, economy in first cost, efficiency and durability had all to be sacrificed in the endeavor to store the greatest power with the least space and weight, and make it available for the variable demands of a street car motor. Thus, the storage battery has acquired a bad reputation among engineers; and it will take some time to overcome this. It must be plain, however, that with no limitations as to weight, or as to use of liquids, and without the destructive jar and rattle to which the storage battery on a car is subjected, it is possible to make a battery cell for station service which will be far more successful than such cells have been on cars.

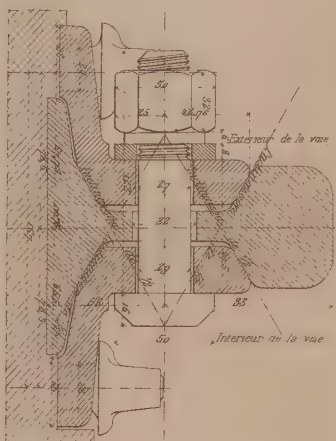
The World's Columbian Exposition was formally closed on the night of Oct. 30, after a most successful season, and it is stated on the authority of Mr. Seeberger, the Treasurer, that after all debts have been paid, there will probably be at least \$1,000,000 available for distribution among the stockholders. As usual, the attendance grew rapidly from week to week up to the very end, beginning with disappointing aggregates. The total paid admissions numbered 21,438,915, and the 5,938,818 pass admissions for employees, exhibitors, press representatives, concessionaires, etc., bring the total attendance up to 27,377,733. The total by months is given in the following table:

May	1,050,037
June	2,675,113
July	2,760,263
August	3,515,498
September	4,638,902
October	6,790,102
Total paid admissions.....	21,438,915
Passes of all kinds.....	5,938,818
Total attendance	27,377,733

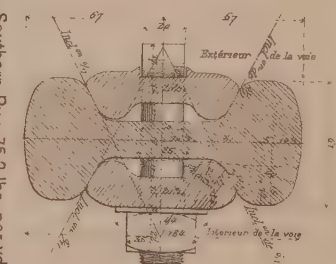
The total expenditures of the company up to Oct. 31 amounted to \$30,558,849, or three times as much as estimated. The gate receipts were a little over \$10,000,000, and the payments from concessionaires were nearly \$4,000,000, while the total receipts were about \$28,500,000. In regard to this latter sum, it may be noted that the receipts from concessions at the Centennial Exhibition of 1876 were \$1,200,000, and at the Paris Exposition of 1889 were only \$800,000. The gates will still be kept open, and it is expected that the admissions will be nearly 1,000,000 up to the time of the final dismantling of the buildings and grounds, as it will take a long while to get the exhibits out, so that there will be much to interest visitors for considerable time to come. There is even some talk, which it is greatly to be hoped may prove more than talk, of preserving the Court of Honor intact for some years. The Exposition has been a re-



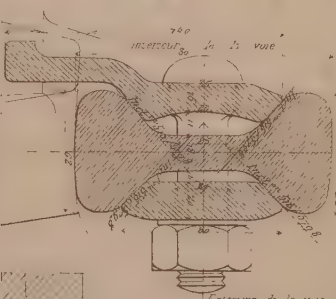
Eastern Ry.; 60 lbs. per yd.



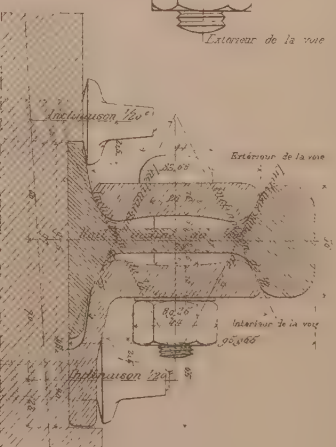
Eastern Ry.; 88.4 lbs. per yd.



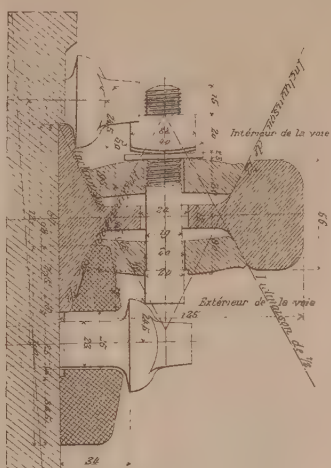
Southern Ry.; 75.2 lbs. per yd



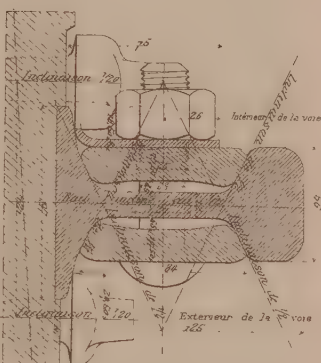
Western Ry.; 77.5 lbs. per yd.



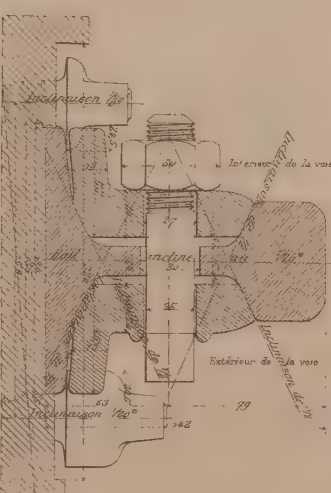
Western Ry.; 60 lbs. per yd.



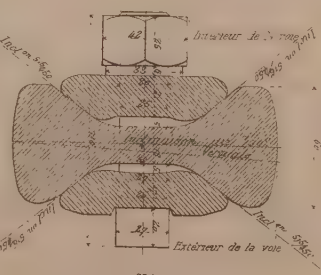
Northern Ry.; 60.6 lbs. per yd.



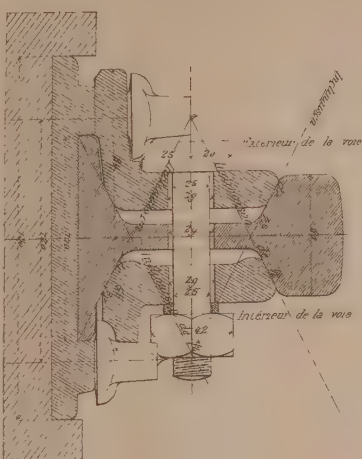
Northern Ry.; 60.6 lbs. per yd.



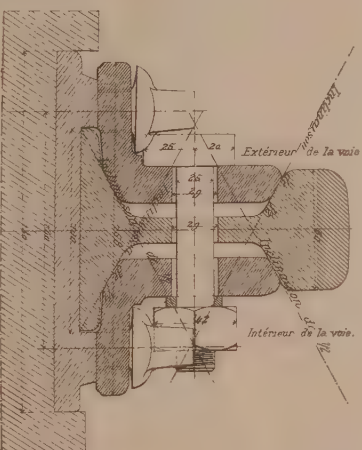
Northern Ry.; 86.43 lbs. per yd.



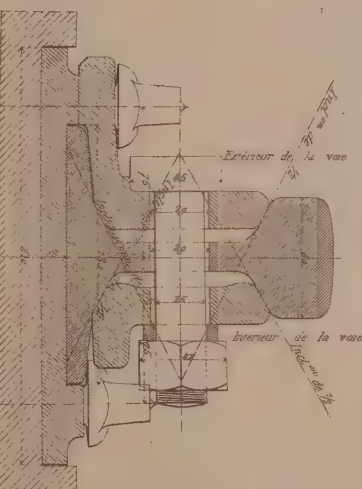
Orleans Ry.; 76.4 lbs. per yd.



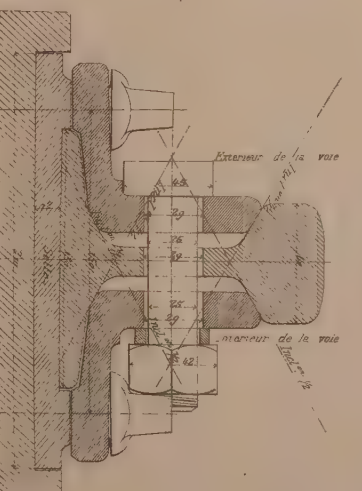
Paris, Lyons & Mediterranean Ry.; 68.4 lbs. per yd.



P. L. & M. Ry.; 68.4 lbs. per yd.



P. L. & M. Ry.; 77.6 lbs. per yd.



P. L. & M. Ry.; 77.6 lbs. per yd.

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markable and grand success in every way, and although it is hard to foresee with much certainty what the future has in store, it is not likely to be equaled in beauty or completeness by any exposition which the present generation will be privileged to see.

THE COMPENSATION OF ENGINEERS.

We have received from one of our younger subscribers (at least, we take him to be such) the following letter for publication. It relates to a subject of such perennial interest, and one on which so many engineers have decided opinions, that we make it the text for a brief article, albeit we have before at one time or another, said most of what we have to say:

Sir: I have read with considerable interest several recent articles in *Engineering News* touching on the cause of the low value set on engineering services by the public. It seems to me that the fault lies more with the men who have reached the higher ranks in the profession than with the younger and less experienced men, for as long as those having in their hands the fixing of the salaries to be paid to subordinates hold their services at so small value as they do, the public at large cannot be blamed if they in turn hold the services of the superiors at a proportionately low figure. Nor can the younger men be blamed for taking the salaries fixed by them as a standard of professional remuneration when coming in direct competition with their former chiefs.

In every branch of the profession men of education and experience can be seen occupying positions of responsibility and trust who receive smaller pay than the superintendents or walking bosses of the contractors on the work under their charge, while their corps of assistants are poorer paid than any of the foremen or masons on the work.

So long as the public see the men who are doing the ostensible work and who have the same technical education, if not so long an experience as their chief engineers, held by them in apparently less esteem (as shown by the pecuniary value set on their services) than the laborers on the work, just so long will engineering continue, as it is now, the worst paid and least esteemed of the professions. A Rodman.

The numerical majority of our readers are doubtless young engineers, because the younger men largely outnumber the old in all professions. Young or old, however, there must be few of our readers who either do not feel or have not felt a certain annoyance from the contrasts to which our correspondent refers. It might be easier and more politic, therefore, for us to publish his letter with some brief note of sympathy and approval, since we could so word such a note as not to violate our convictions while seeming to agree more or less with our correspondent.

We judge it to be more really helpful, however, to say at once that our correspondent's letter is, in the main, an example of wrong headedness, of wrong conclusions and wrong premises of fact; and that the young "rodman" who is nursing such grievances in his mind instead of giving all his thoughts to doing his work well and learning how to do it better is doing the best he can to ruin his whole prospects in life.

Let us begin with his closing statement, that engineering is "the worst paid and the least esteemed of the professions." As respects the younger members especially, this statement (which is, in fact, the premise of his argument) is wholly untrue. On the contrary, there is no other profession, or calling in the nature of a profession, known among men in which a young beginner of the average age, experience and acquirements of "a rodman" can earn anything like the salary he receives. Most doctors and lawyers and ministers, and even architects, of twice his age receive no more, and at his age and for years after earn hardly enough to keep body and soul together. And especially is this true of the brighter ones, who are booked for the future prizes of the profession, and hence are giving all their thoughts not to getting the largest immediate earnings, but the largest stock of experience.

This rule of an exceptionally large compensation for the younger men holds right through all ranks of the profession up to the very top, but with decreasing force as the top is approached. The very fact that the young men have so good a chance to begin earning good salaries in their earliest years when they are really only learning their profession is one of the facts which keep down incomes at the top and create there some real grievances in respect to salaries and professional fees; but even there these grievances are much less than appear. We must consider not only the compensation which

prominent men receive as such, but also the opportunities they have for entering into related and more lucrative occupations because of their training as engineers. These opportunities are not paralleled by the opportunities for diverging from any other profession. They, of course, tempt men to continue in the practice of engineering, and so are fairly to be counted among the emoluments accruing to the engineer as such. Contingent opportunities of this kind count for much in keeping him in engineering. Accordingly we find that the membership of our leading engineering societies is very largely made up of men who have thus diverged into lucrative callings for which engineering has trained them; and if the average income of the members of such a society could be determined, we are confident it would prove greater than the average income of any equal fraction of the men at the top of any other profession; or nearly enough so to show that there is at least no serious relative injustice.

Now, it stands to reason that a profession offering such advantages both to the young men and the old (if only they show competency for their special work) cannot possibly exist without drawing many men into it, and hence without a sharp competition among the younger men for a standing in it. It is so in all professions, and in all callings whatsoever of the more attractive kinds. It is a part of the eternal order of things. It cannot be avoided if we would, and it should not be avoided if we could, because this competitive probation among the younger aspirants is the only possible perfectly fair way for determining who is to stay in the profession and who is to step down and out into some calling more suited to his capacities. Hence the junior ranks of every profession and desirable calling must always be overcrowded; there must always be somewhat more aspirants for places than places for aspirants. If by any chance it is not so one year, more will offer next year. Under these circumstances, what do the chief engineers do? The better class of them (which means three-fourths of them) insist, first, on a pretty high standard of qualifications regardless of price; and second, on paying no more than is needed to secure the grade of men they want, which, of course, will be less in proportion to the excellence of the opportunity which they offer in the respects of experience and future prospects.

What else would our correspondent have them do? Can he not perceive that it would be base robbery and favoritism for them to do anything else; robbery of their employers; favoritism toward the employed? Can he not perceive that the money paid for junior services is only a part of the compensation, and often a small part, the greater portion being the opportunity to learn and get ahead? He is himself (to judge by his letterhead) in one of the best schools for the engineer on this continent, in the direct line of promotion to any position for which he shows himself qualified on that road or any other, up to that of president of some great corporation. Instead of rejoicing at this opportunity, and studying to improve it, he is wasting his energies in envious feelings toward the gray-headed walking-bosses and stonemasons whom he sees around him, who have no such possible future as he has, but have reached about the limit of their hopes, because they are drawing more pay than he does!

But, besides the unreason of thus ignoring differences of age and prospects and attractiveness of occupation, there is an element of still greater folly in his assumption that the work he does is intrinsically worth more and should be paid more than that of the men with whom he compares himself. Who is our correspondent? His letter reveals him completely. He is a young man who may or may not have the making of a successful man in him, but who at present merely knows a little about many things, but all there is to know about nothing. The world is not paying much for that kind of knowledge, for the very good reason that it is not worth much. What the world wants and pays roundly for is the man who knows how to do one thing thoroughly well, better than almost any one else who can be found, and who does it withal faithfully and simply, so as to keep things moving smoothly. The good walking-boss is a rare bird, much rarer than the good assistant engineer who

sticks the pegs for him and measures up his work, and is worth intrinsically a good deal more money. Naturally he gets it. After the assistant has learned by observation the walking-boss's and stonemason's art as well as his own, then his day comes, and the walking-boss and stonemason is no longer a competitor.

But then, the education! Ah, yes, the education! Our correspondent is not only jealous of the walking-bosses and stonemasons, but he is indignant that all men of "the same technical education if not so long an experience" as his chief engineer, do not approximate to his chief in salary instead of to the walking-bosses. In other words, he is indignant that there should be so considerable a gap between the chief engineer's salary and his own, since both have (by assumption) received the same "education." Pushing the argument a little further, if the assistant has happened to receive a considerably better education than his chief, it might be urged that it would be a great shame if he did not receive more salary.

On this head also let us say a few plain words. The market value of education as such is almost nil, for the very good reason that its real value is almost nil. What the world yearns for and pays for roundly in any calling is accumulated and assimilated experience and character and "faculty," whether it be accompanied by much booklearning or not. When these qualities are combined with a real education, in the sense of a comprehensive knowledge of any art or science, then the man has a walk-over through life. But even such knowledge in itself has but a trifling market value (sometimes regrettably so, but not often) though it takes a lifetime to acquire it. The kind of knowledge which our correspondent refers to as his "education" is well understood by all intelligent men to be nothing more than a smattering of a few fundamentals, which amounts to nothing except as a foundation, and whose greatest value is that it has taught the youth how to acquire knowledge in the future for himself and has given him a taste for it. It is absurd to expect that such a mere smattering of knowledge will have much weight in determining a young man's salary. It never does. The advantage which the college graduate has over the non-graduate is almost wholly that his mind is in better condition to profit by further knowledge as it comes to him, and in the presumption of aptitude which his college course affords.

But, we find ourselves obliged to say in conclusion to our correspondent that even the kind of education he thinks he has, he has not. We judge him to be a graduate of some engineering school, but his college could not or would not, at any rate it did not, insist on his having even the most fundamental elements of a common-school education as a condition of graduation. He cannot spell; he cannot punctuate or use capitals properly, or write grammatical sentences. At least, he does not. His letter, as published above, is not really his; it is our revised and corrected version of it. If we published it just as received he would himself be shocked by it. We have not spoken of this before because in a less degree it is a very common fault. We receive very few letters, even from well known men, which do not require some little correction of this kind. But no man who writes for publication about his "salary" will ever receive much from a self-respecting company. He would discredit himself and them in a responsible position. Therefore we earnestly advise our correspondent to cease repining because his college education is not appreciated, and to devote himself instead to perfecting these elements of education which he ought to have been required to have before he was allowed to enter college.

"Faithful are the wounds of a friend." If our correspondent and many other young aspirants like him will take these hints in good part, and try to profit by them instead of getting angry at them, his future path in life will be much smoother; and 20 years from now he will see clearly what we now see, that he really has little to complain of and much to be thankful for in his present state. One word more: This is a time of reductions of force. The grumblers and indifferent malcontents are always the first to go. It is just that they should be the first.

LETTERS TO THE EDITOR.

RAILWAY CONSTRUCTION IN BOLIVIA.

Sir: Will you permit me to call attention to one or two points in the article "Railway Construction in Bolivia," published in your issue of Oct. 19. It can hardly be said that the railway from Arica to La Paz is "partly completed." It is true that there is a short line from Arica to Tacna, but this was built some years ago, with Tacna as its objective point. No difficulties whatever presented themselves in this work, as the road winds by easy grades through a valley to an elevation of only 1,800 ft. There was a proposition to extend the line to La Paz, 250 miles further, and preliminary surveys were made. The building of this line was the dream of the Tacna and Arica merchants, as it would divert through their towns the business of a large part of Bolivia; but the engineering difficulties and estimated cost of construction were too great, and the project was abandoned.

In the meantime the Antofagasta & Oruro R. R. had been begun, and was being pushed rapidly to completion. This road furnishes railway communication to the very region aimed at by the Arica & Tacna line, and for a long time, at least, will effectually prevent the revival of the latter scheme. The statement is made regarding the Antofagasta road that the difference in elevation is "13,087 ft. in a distance of 560 miles, or 23 ft. per mile." As a matter of fact the road reaches its highest elevation of about 13,000 ft. near Ollagua, 270 miles from the coast, with an average grade of 47 ft. per mile. Up to this point there are many long and rather heavy grades, but no difficult work, excepting the bridge over the Loa River. From Ollagua to Oruro the work was of the easiest description, with light grades and many long tangents. The proposed line from Tacna to La Paz would be incomparably more difficult and costly than the Antofagasta R. R. Yours truly, R. Peele, Jr.
New York, Oct. 21, 1893.

Sir: The proposed connection of the Paraguay and Bolivian extension with the southern system of the railways of Peru, at Santa Rosa, as stated in your last issue, can be improved upon. La Paz is on the eastern side of the ridge which divides the waters of the Amazon from those flowing into Lake Titicaca, so a line starting from the latter valley and returning to it would have to make two crossings of this ridge. La Paz should be reached by a branch line, in either case, whether the main line goes east or west of the lake. The best place for the main line is on the west side of the lake, and the shortest connection that can be made by a line coming from the south is at Puno. If the line has to go on the east side of Lake Titicaca, the connection should be made at Juliaca, the starting point of the road, to Cuzco, and 70 miles south of Santa Rosa. This small town is near the head of the valley that extends northward from Lake Titicaca; and to make the proposed connection there the lines would approach each other at a very acute angle, as far as Ayaviri, and be side by side from there on. At Juliaca there is ample room for the largest yard that can be required, with light work, and not over 0.2% grade. At the other place there is but little yard room, and the grade would be over 1%. Within the last three years the Cuzco road has been extended northward to Sicuan, less than 50 miles from Santa Rosa, and its further extension is very uncertain.

Jas. R. Maxwell.

Philadelphia, Pa., Oct. 22, 1893.

THE CHAPIN MINE PUMPING ENGINE.

Sir: We are in receipt of yours of Oct. 9, together with proof of description and editorial on the Chapin mine pumping engine. With the description in a general way we have no fault to find; but in the editorial you seem to have started out to prove that this firm, as mechanical engineers, have not kept up with the advance in the methods of transmitting power, particularly by electricity. In regard to this matter allow us to explain the circumstances under which this engine was designed and built.

The matter first came up for discussion between four and five years ago, when Mr. C. H. Cady was Superintendent and Manager of the Chapin mine. At that time Mr. Cady investigated the various types of pumps, including pumps located underground, and also an electric plant, to be located at Quinnesec Falls, and received approximate estimates from the electrical people on the cost of such plant. But if we remember rightly, while the electrical people then, as now, were willing to talk of a large percentage of the generated power being transmitted and transformed into useful work at the mine, when it came to their making a positive guarantee as to this, we believe that none of them would guarantee above 50% efficiency; and the entire cost of the plant was not materially less, if any, than the cost of a steam plant for the same work, particularly when the uncertainty as to the water power in the winter required an auxiliary steam plant

and generators to be located at the mine. We have not the exact figures for the electric work at the mine, as Mr. Cady himself investigated the matter; but the facts are substantially as above given. You must remember that in four years the practical application of electricity has made great progress, and what the electrical people were unwilling to guarantee at that time they would perhaps now contract to do, but we consider it rather unfair to criticise us for work designed more than four years ago, in comparison with what can be done now.

We ourselves are somewhat familiar in a general way with the applications of electricity for the transmission of power, as we have used it in our works for several years, and built the first electric crane operated in the United States, and it was through our influence that the first direct-connected generators to run at moderate speeds were built in this country.

The Chapin mine engine was not designed to run by compressed air excepting in case of emergency; for instance, when the mine was shut down and the air supplied by the compressors at the falls was not required for use underground, so that the question of economy of the engine when working with compressed air cannot properly be considered as one of the factors in the case.

With the present compressed air power plant something over 50% of the power developed by the water wheels is realized in work done by the old geared pumping engines at the Chapin mine, and even with this efficiency it was considered cheaper to put in a steam plant than to increase the air compressing plant at the falls, together with the necessary increase in the pipe lines, etc.

The basis on which you figure the economy of the Chapin engine as compared with an electric plant is entirely wrong. You assume a theoretical pump horse power of 192 and then for some unknown reason assume that the I. HP. would be 500. As a matter of fact, we have indicator cards from this engine running at four revolutions per minute showing only 214 I. HP. In addition to this there is properly chargeable to the engine about 15 HP. required to operate the independent condensing apparatus, making a total horse power of 229 instead of 500, as you assume. This would give an efficiency of about 83½%, and this efficiency would increase slightly as more pumps are added or the engine speeded up, so that 15% would represent the total loss in friction of the parts of the engine and pumps. We have not time to analyze your figures further than this; but if they are as far away from the facts as they are in this case, such analysis would be a mere waste of time. In regard to the engine itself, we would say that it was selected by the Chapin mine management from among several designs submitted by us, and, except for its enormous size, it does not present many novel features. Your remarks about the use of single large valves, when the tendency is toward the multiplicity of small valves, has no force in this case, as the general designs of pumps and valves were submitted to us by the Chapin Mining Co., the designs being by their Master Mechanic, Mr. Edmund Kent. It is perhaps sufficient to say that these valves work admirably, but that we, in our designs, have used no valve larger than 3½ ins. diameter for the past eight or ten years.

Viewed now as a commercial question, we are free to admit that a better pumping plant might be designed; but four years ago, after considering all the plans offered, the Chapin Mining Co. decided that this particular one was best suited to their needs. In addition to the Lehigh Zinc Co.'s engine which you mention, there is at least one other example of this antiquated type of engine in this country. We refer to an engine designed a few years ago by Mr. E. D. Leavitt, and built, we believe, by I. P. Morris & Co. This engine is at the Ontario mine, Utah. The illustrations of the details of the pumps, etc., of which you have sent us a copy, are very well executed; but after reading your editorial it is difficult for us to understand why you took the trouble to illustrate this machinery unless it was intended to show young engineers what not to do.

Yours truly,
The Edward P. Allis Co.,
Per Irving H. Reynolds.

Milwaukee, Oct. 18, 1893.

(We cannot make a better reply to the main part of our correspondent's letter than to reprint the following paragraph from the editorial referred to:

There is, however, one reasonable excuse for the adoption of the steam plant at this mine. At the time that the general type of the plant was decided on, nearly four years ago, we believe, electrical apparatus, and especially apparatus for the electrical transmission of power, was in a comparatively imperfect and experimental stage. It might have been urged, with reason, at that time, that the reliability of an electrical plant was too uncertain to warrant its adoption in so important a place, and doubtless this was what settled the rejection of the electrical plant, if it was given consideration at all.

It is fair to say, moreover, that it is improbable that any blame should attach to Messrs. E. P. Allis & Co.,

the builders of the engine, for the adoption of a less efficient and more costly system than might have been used. They were merely the contractors for the machinery, the general design of which was probably determined upon by the officers of the Chapin Mining Co.

Our correspondent will see from the above that we appreciated the fact that the problem presented four or five years ago was not at all the problem presented to-day, and that we had already surmised the fact that the contractors were not responsible for all or even for many features of the design. As for what our correspondent says concerning the efficiency of the engine and pumps, we will say frankly that the figures are a surprise to us and are far higher than we supposed possible. Evidently the single-acting pumps must work with very little loss at the low speed of four revolutions per minute, whereas we allowed for a large loss in them in our estimate. The friction of the engine also is surprisingly small considering its enormous size and weight. It speaks volumes for the high class of workmanship of the E. P. Allis Co. if this ponderous machine with its 100-ton walking-beam, and all the pump rods, plungers, balance bobs, etc., can be turned at the speed stated with a friction loss of only 22 HP., including all the loss in the water itself.

As for our correspondent's query why we took pains to illustrate this machinery, we illustrated and described it as part of the engineering history of the day, it being a large and important machine, constructed by a firm of high reputation, and put into daily and successful use. It certainly possesses such interest that any engineer visiting its vicinity would take the trouble to examine it for himself. It is to machines and structures actually built, with all their excellences and defects (and there are few pieces of work but have more or less of both), that the practicing engineer must look for precedents to guide him. Probably no engineer in the future will wish to duplicate the plant at the Chapin mine; but it does not follow that because the general design is superseded, the details of the mechanism contain no information of practical value to engineers.—Ed.)

Sir: I am very much interested in your editorial on "The Best Method of Draining Deep Mines," as I made quite a study of the Chapin mine problem at the time they contracted for the Cornish engine to which you refer. I think that you are a little hard on the "average engineer" in stating that his most prominent fault at the present time is his neglect to keep informed and take advantage of every invention and improvement, especially, as in the same article, you tell him what should be done, but you do not state facts or tell him what is being done.

I do not care to discuss the question of water power and compressed air versus water power and electricity, because I have had no experience with this class of pumping; but I would like to call your attention to some facts in reference to pumping by steam pumps versus pumping by electrical pumps with dynamos driven by steam engines. In referring to the loss of power of transmission in the Cornish engine, I notice that you state, "(E), walking beam and pump rods; (F), pumps," while in electrical pumps it is, "(D), motors transforming current to mechanical energy and connected directly to (E) pumps," leaving the impression that the losses in an electric plant are less than the other. This should be, for the electric pump: (D), motors transforming current to mechanical energy; (E), mechanism connecting motors to pumps; (F), pumps. The loss due to (E) in this case is found by actual experience to be greater than the loss due to (E) in the case of the Cornish engine.

But why discuss these matters and attempt to tell what should be? Is it not better to take the facts in the case as they are under actual conditions? The Cornish engine at the Chapin mine will show a duty of over 100,000,000 ft.-lbs.; i. e., less than 2 lbs. of coal per HP. of actual work measured by the water column, generally called pump horse power, per hour. You are right in saying that pumping by electricity is no longer an experiment. There are enough plants in operation to show that the duty obtained does not exceed 70,000,000, or 2.85 lbs. of coal per pump HP. per hour. The same experience which has shown that electric pumps are a success has also shown that their cost of maintenance is very great and their life comparatively short.

I am willing to allow that large Cornish engines, on account of their high first cost, are not good investments, but there is a class of steam pumping engines on the market at the present time that will cost no more than the electric pumps mentioned, and, with all the losses taken into consideration, will pump more

water per pound of coal burned, require less attendance and cost less for maintenance than any electrical pumping plant in existence, on the scale mentioned in your article.

I am surprised that in mentioning the Lehigh Zinc Co. engine you did not also call attention to the Cornish engine at the Ontario mine, which is much nearer the Chapin engine in design than the one referred to at the Lehigh Zinc Co., and has an excellent record of efficiency.

Yours truly, C. B.

New Brighton, Staten Island, Oct. 21, 1893.

(We beg the "average engineer's" pardon if we have framed too broad an indictment of him respecting his tendency to conservatism, as our correspondent thinks. We may discuss this matter more fully at another time; at present we will only say that the tendency to conservatism on the part of many members of the profession is entirely natural and is entirely meritorious, when it is not carried to excess.

Our correspondent says that experience shows the friction losses in the gearing connecting an electric motor to a pump to be greater than the friction losses between the engine and the pumps in a Cornish pumping plant. But the mechanism in the former case may have been badly designed and constructed, and in the latter case both design and workmanship may have been of the best. It would certainly seem that an electric motor ought to be made to transmit its power to pumps mounted on the same frame with less loss than would occur in transmitting the same power through a walking-beam and down a shaft several hundred feet by massive rods, with all the other attendant complications of the Cornish pumps.

The duty of 100,000,000 ft.-lbs. per 100 lbs. of coal, which our correspondent claims for the Chapin mine engine, seems surprisingly high, and the duty of 70,000,000, which he assigns to the electric plant, correspondingly low, when the advantage is considered which the engines, dynamos and motors have of working under a steady load.

Reference is made to the cost of maintenance and short life of electric pumps. It is true that early types of electric motors were unpleasantly liable to breakdowns and failures; but great improvements have been made in insulation and in methods of construction during the past few years. In comparing electric plant to-day, it is fair to take the best machinery which is now available in the market, and not that which was installed two or three years ago.

As for the comparison between underground direct-acting steam pumps and an electric pumping plant, we should say that the choice between them would hinge largely on the depth of the shaft. At any moderate depth the steam plant would doubtless be preferred; and it is only in deep shafts that the loss by condensation in the steam pipe would be enough greater than the loss in the wire transmission to offset the loss in the dynamo and motor. —Ed.)

THE INTERNATIONAL IRRIGATION CONGRESS.

Sir: The International Irrigation Congress, which closed at Los Angeles on Oct. 14, was notable particularly for the emotional and political character of its deliberations rather than for its eye to business. The statements of Messrs. Powell and Newell, of the U. S. Geological Survey, indicating an insufficiency of rainfall in the arid region to do more than irrigate lands already taken up, leaving nothing available for government land not yet disposed of, were received with extreme disfavor. It was as much as Mr. Newell could do to get permission to revise his statement before it went into the printer's hands, and Mr. C. C. Wright, author of the District Irrigation Law of California, went so far as to propose that Major Powell's statements should be expunged from the records. The good sense of a majority of the members finally prevailed, however, and allowed all parties offering papers or verbal discussions to revise the same for the printer.

The congress, in its address to the people of the United States, opposed the ceding of the arid lands to the states. The chief grounds for this action was the fact that many of the streams used for irrigation run through two or more states or territories, and even, in the case of the Rio Grande and the Colorado, upon foreign territory, making their regulation and distribution a national question.

Apart from the attempt at suppression of evidence adverse to the views of the majority, the unbusiness-like attitude of the congress was notable in its treatment of the clause of the address emphasizing the right of the public to take possession of private prop-

erty (irrigation plants) upon payment of their appraised value. It was acknowledged in the course of the discussion on this clause by its adherents that this right was covered by the U. S. and state constitutions, and attention was also called to the effect this would have on capital. Notwithstanding this, the clause was approved almost unanimously. In submitting this clause, or the one corresponding to it in the first report from the committee on resolutions, the chairman of the committee said that the appraised value would not be the past value nor the future value of such works; not the money put into them, nor the value as represented by future expectation of profit. If the works were not worth what they had cost to build the owners would have to lose the difference; if they had appreciated in value since building, the owners would gain by so much. This sounds eminently fair to the non-expert, but if we recall the usual history of such works it will be seen how repellent such a possibility of condemnation is to the investor of capital. In constructing any work of a semi-public character, and this is particularly true of irrigation works, obstacles are almost always encountered requiring changes of plan involving losses of work done, sometimes of a very serious character. Hence, when the works are completed, it will generally be found that they could be rebuilt at much less than the original cost. On the other hand, the promoters are forced, in order to attract custom, to offer more favorable rates at first than will really afford them an income, at a time, too, when the business is slender in character. Later, as the enterprise becomes more assured, rates are stiffened until, with the natural increase of business, the income gives a handsome return on the invested capital; and in course of years, the income will show an average interest on the capital invested equal to that usually expected from commercial enterprises. If the public would wait until this time before condemning the property and then appraise its values as an income-paying concern, there would be no particular hardship in the matter, but the tendency would be to seize the plant when rates began to appear onerous. At that time, if appraised either on the basis of income or at the cost of rebuilding the works, the parties supplying the capital would be left badly in the lurch.

The great difficulty with irrigation enterprises at the present day is the fear on the part of capitalists of legislation adverse to the interests of non-resident owners, and this fear must be largely increased by the declarations of the congress.

The things needed to-day for the promotion of irrigation are: (1) A uniform system of legislation in regard to water rights and as to property in irrigation enterprises, making such enterprises attractive to capital. (2) Satisfactory information as to what water is available and exactly where it can be applied. (3) A general plan of reservoir sites and of the proper courses to be taken by ditches and conduits in the different irrigation districts to avoid unnecessary multiplication of the latter; such as has taken place in the upper Arkansas Valley, for instance.

If these requisites are satisfactorily arranged the prosecution of irrigation may be safely left to private or local public enterprise. Reviewing the action of the congress, it may be said that on the first point it acted wisely in appointing a general executive committee made up of state and territorial delegations to gather information, each delegation in its own district, after which the general committee is to formulate a scheme of legislation, to be recommended to the U. S. Congress. On the other hand, it has acted unwisely in emphasizing unnecessarily the right of confiscation by the public of private irrigation enterprises. On the second point it presented a very unfortunate animus toward facts or evidence tending to show the impracticability of irrigation in any given section. On the third requirement the spirit of the convention was generally favorable to government supervision and unfavorable to the attempt to get national appropriations for irrigation works. Yours very truly,

W. Howard White, M. Am. Soc. C. E.
Redlands, Cal., Oct. 17, 1893.

STORAGE BATTERIES IN ELECTRIC GENERATING STATIONS.*

By C. O. Mailloux.

The advantages of using storage batteries, which seem to be much better appreciated in Europe than in this country will be best understood by reference to the accompanying load diagrams.

Fig. 1 shows a load diagram from the Minneapolis Street Ry. Co.'s station.** This figure may be compared with Figs. 2 and 3, which show load diagrams of an incandescent lighting station. Taking the lighting station diagram in Fig. 3, which more nearly represents the usual condition of affairs in lighting

*Condensed from a paper read before the American Street Railway Association at Milwaukee, Wis.

**From "Electric Railway Motor Tests," by Prof. Geo. D. Shepherdson and Edw. P. Burch. Trans. Am. Inst. Elect. Engrs., Vol. IX., p. 379 (1892)

stations, it is seen that the momentary irregularities, or fluctuations, are trivial in comparison with the changes or variations of load from hour to hour or from one part of the day to another.

The railway load diagram, on the other hand, shows a series of ups and downs every few minutes all day long, and diagrams of the output at shorter intervals show still more marked irregularities and jumps.

The greater the number of motors supplied from a given source, the less likelihood is there of the load being thrown on or off in such large proportions. The load then "averages itself," to use a current expression.

Thus, in Fig. 1, the fluctuation on the whole system is about 20%, but the fluctuations in the load on any given part of the system would be found to be far greater. On a small road, running only a dozen or fifteen cars, the load will often fall to zero or run up to two or three times the average load, in the course of a few minutes.

These fluctuations cost the railway companies money in three ways: (1) They involve the use of generating machinery of greater capacity than would be required if the machinery were operated at a constant uniform load. (2) The depreciation is greater. (3) The efficiency of the machinery is lower, owing to the fact that the use of engines and dynamos larger than would be required for the mean load increases the percentage of energy spent in the engine and dynamo to overcome friction and also to energize the field magnets.

Fig. 4 is plotted from an actual case of load variation in the Brooklyn Edison station. The curves show that by the time the load drops 40% the efficiency falls off very rapidly.

Now estimate that the steam consumption in the average engine plant is 20% greater than it would be if the plant did not have to be made larger than would otherwise be necessary in order to carry the extremes of load. Estimate also that the engine and dynamo utilize 15% less of the indicated horse power than they would if run at their economic load point, and we have the loss in efficiency of the plant due to the variable load at over 30%.

Use in Lighting Stations.

The use which has already been made of the storage battery for regulating the load in the central stations for electric lighting service is quite extended.

By courtesy of Mr. R. R. Bowker, Vice-President and Manager of the Edison Illuminating Co., of New York, and Mr. William L. Pakenham, of the Crompton-Howell Electric Storage Co., of London, your committee is enabled to reproduce the two interesting curves, Figs. 2 and 3, to which reference has already been made, showing the performance of a Crompton-Howell storage battery, which is in use at the Edison Illuminating Co.'s 53d St. supplementary station.

The storage battery, like the station itself, was installed provisionally and by way of experiment, as it were, without paying very strict attention to the size, capacity or other conditions necessary to obtain the best results. The battery is installed on the second

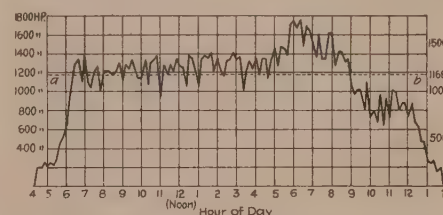


Fig. 1.—Load Diagram of the Minneapolis Street Railway Co., March 4, 1892.

Dynamo potential, 500 volts. Car mileage: 1,425 motor cars made 15,638 miles, 42 trail cars made 2,400 miles.

floor above the engine and dynamo room, and consists of 140 cells, each of about 1,000 ampere-hour capacity, weighing some 750 lbs., about 48 ins. long, 21 wide and 15 deep.

The battery has a normal discharge rate of about 200 amperes, but can be discharged, if necessary, at 500 amperes. Fig. 2 shows the station record for April 22, 1893. The station was then running only 12 hours per day, or from noon to midnight. The total load of all the stations, being light in the afternoon, the larger stations could easily take care of it; hence the only station load from 12 to 5:45 p. m. was that required to produce the charging current for the batteries. The plant was running at perfectly constant load, as shown by the straight line, a b. The lightly shaded area below this line represents the current (ampere hours) put into the battery. By 6 p. m. both the station machinery and the battery were delivering current into the mains. The curve b d e f g shows the total current. The curve c h j k g shows the amount delivered by the dynamos direct; the rest, or the dif-

ference represented by the relative heights of the two curves at any two points (say h and d), was supplied from the battery. The shaded area between the two curves represents the amount of current put in by the battery. Calculation shows that the battery furnished about 23.2% of the total energy delivered to the mains. The maximum rate of discharge attained by the battery was about 270 amperes. Thus, in this case, we have an example of a battery which is used for the purpose, first, of giving a load to station machinery that would otherwise be idle; second, utilizing the stored energy to increase the rate of output of the station at the time of heavy load, which would otherwise necessitate greater dynamo capacity. In the second curve, Fig. 5, five months later, the conditions have been changed. In the first place, the station output has increased greatly, being now about 2.9 times greater, and it is also continuous, instead of delivering current into the mains only from 6 to 11:45 p. m., as in the first case, the current is now delivered continuously, at varying rates represented by the curve

various parts of one section of the city, and all charged from the same central station.

In the "Edison section" of Paris an interesting application is made of a large (2,800 ampere hours) battery, which is located at a point somewhat distant from the central station, and connected with the mains, from which it is charged at those hours when the load is light by taking current from the mains themselves, the potential being regulated by means of a continuous current transformer. In this way a considerable amount of energy can be sent at a low rate, and therefore at small loss or drop of potential, saving the cost of large feeders, while it also furnishes a load for the hours of small load. This plan suggests itself as of possible service in electric railway systems covering a large area of territory, all fed from a single central station. The batteries could be located at distant points, or at such points as would give the best distribution of current to the trolley lines with the least expensive line work. There are also other stations in France, Italy, Austria and England, some

A cell of the later capacity, weighing, complete, some 4,750 lbs., and about 36 x 39 ins. by 40 ins. high, gives an idea of the scale on which the use of storage batteries in European central stations is carried on. At the Hanover central station a separate building, with four floors, about 70 x 35 ft., is reserved for the storage batteries. The capacity of the batteries is rated on a more scientific and rational basis than has been the custom in this country. It being a well known fact that the capacity is lower when the discharge rate is increased, the practice is adopted of giving the capacities which the same cell will give under different rates.

Either the "Tudor" batteries (made at Hagen, Westphalia) or the Crompton-Howell battery may be discharged at rates up to nearly full short circuit in emergency, but the Tudor battery is not guaranteed for any discharge rate faster than three hours. The Crompton-Howell battery, however, may be discharged in an hour. The capacity of the latter falls to about 50% on one hour discharge. Such extreme rates are

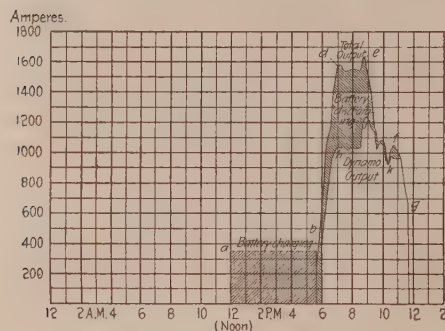


Fig. 2.—Load Diagram of 53d St. Station, Edison Illuminating Co., of New York City, April 22, 1893.

Curves show total current of both sides of three-wire system.

a b c c' e' f g. The station now runs from 8 a. m. one day to about 2 a. m. the next day, or 18 hours. When it starts at 8 a. m. it carries a two-fold load: First, the regular load allotted to this station, shown by the curve c c' e' f; and second, in addition, the load represented by the curve d d' e, which is the current absorbed by the batteries in charging. It is to be noted that the total load is much more uniform than if the station were feeding into the mains alone, for the extremes of current fluctuations shown by the curve d d' e represent a total variation of only 80 amperes on an average load of 850, or less than 9%.

I have been informed within the last few days by Mr. Pakenham, that the battery is now being made to play an additional part of some interest. The maximum load (f) has increased to such a point that the station plant is no longer adequate; and consequently the battery is put on to "cap" the summit of the load and supply the excess of current required above the capacity of the dynamos. When the load begins to fall off, about midnight, a part of the plant is shut down; but since the load is still too heavy for the other dynamos, the batteries again serve to supply the excess, from g to h.

There is only one other case in this country, namely, the Edison station at Germantown, Pa., where storage batteries are used as load equalizers. The total capacity there is of about 1,000 ampere-hours, made up of six or seven early morning hours when the outside load is very light. It stands idle during the heavy load in the evening, and is discharged to carry the load after the plant shuts down. In this case the battery saves the expense of running the plant during the period of small load. Additional capacity is contemplated by the company, and will probably be put in this winter.

A large battery is being installed at the central Edison station in Boston. This battery, of German manufacture (Tudor), will be by far the largest in this country, the cells being over twice the size and capacity of the battery of those in the New York station referred to above. Its adoption was decided upon after a special study made of the use of storage batteries in European central stations, by Mr. C. L. Edgar, the superintendent of the company. The Brooklyn (N. Y.) Edison station has also in contemplation the use of a similar battery.

It is in Europe, however, that the use of the storage battery in central stations has made the most headway. In the city of London alone there are no less than eight stations supplying current for incandescent lighting, in which storage batteries are depended upon for part or the whole of the load carried. In Paris there are some 20 or 30 such sub-stations located in

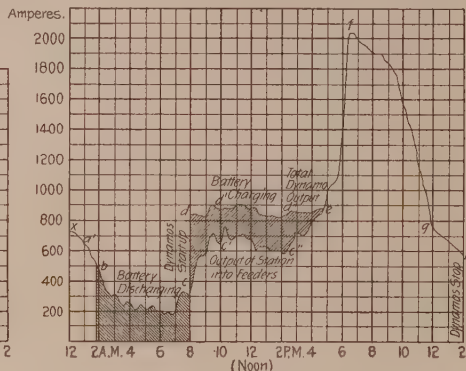


Fig. 3.—Load Diagram of 53d St. Station, Edison Illuminating Co., of New York City, Sept. 30, 1893.

Data calculated from the curves. Output of station for 24 hours, b to h, 19,988 ampere hours; output of dynamos, d to h, 20,124 ampere hours; output of battery, b to c, 1,632 ampere hours; load factor, 20.8%; Quantity, 8.1%; charging current, d to c, 1,768 ampere-hours; average time and rate of charge, 8.75 hrs., 202 amperes; average time and rate of discharge, 6.25 hrs., 261 amperes; current efficiency of battery, 92.3%; current efficiency of station, 99.3%; current loss (total), 0.7%.

of them large and of great interest, where storage batteries are used as regulators, including cases where steam engines, gas engines and water power are used.

Batteries Used.—The data which your committee has been able to obtain regarding the storage batteries used in the applications just noted demonstrate the fact that there is a wide difference and distinction between the storage batteries used for these applications and the storage batteries with which the American street railway engineer and manager are familiar. The experience had in America with storage batteries would naturally lead one to expect that very radical improvements would be necessary to render these extended applications feasible and successful. The close study and analysis of the evolution which the storage battery has undergone under European auspices indicates, however, no evidence of any great radical departure in principle or construction. It must be admitted that the conditions are eminently more favorable in the case of stationary batteries than in the case of portable or of traction batteries to be carried by the cars themselves; for the limitations of size and weight in relation to capacity are not serious or do not exist at all, to say nothing of the advantages realized in other respects. It is recognized, as a condition of success by the Europeans, that the principal objects to attain are long life and high efficiency, even at the expense of increased first cost. Instead of attempting to obtain 10 ampere hours per pound of battery element, the manufacturer limits himself to two, three or at most four.

The Plante process of formation and its modifications would seem to have proven itself superior to the pasting or Faure process, if one can make a criterion of the fact that at least nine-tenths of the aggregate of the central station batteries used is of the Plante type, or some modification thereof. The Plante batteries are conceded to be, usually, of lower capacity per pound, but they are able to carry heavier rates of charge or discharge. The battery plates are made of much larger size than usually made in this country, and only a few sizes (often only one) are made; the various capacities of cells being made up by adding the requisite number of plates. This simplifies the matter of extension. The cells are usually made of tarred wood lined with lead.

Capacity.—There is probably no storage battery cell on the market, of American manufacture, having as much capacity as 500 ampere hours. In Europe they can be procured up to 5,000 ampere hours capacity.

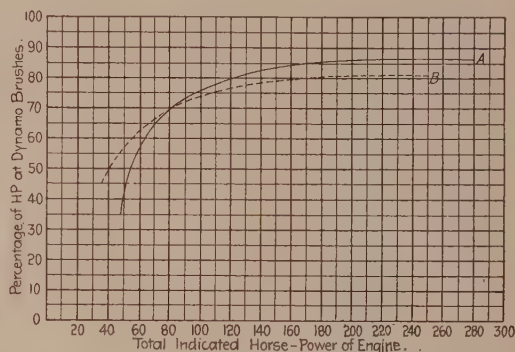


Fig. 4.—Variation in Efficiency of Engine and Dynamo Plant with Variable Load, Brooklyn Station, Edison Electric Illuminating Co.

Curve A is for a vertical compound engine direct connected to a pair of 100-K-W. multipolar dynamos. Curve B is for a high speed compound horizontal engine belted to two Edison 70 K-W. generators.

not, therefore, to be recommended, and their use is limited to emergencies, where they are often of the greatest value. The ability to increase the rate of delivery 100 to 500% in case of emergency, is indeed one of the qualities which recommends the storage battery for central stations, as there is no other generating outfit that can possibly approximate such extreme rates. In such cases the convenience is of far greater moment than the efficiency of the device. The variation in voltage is slight in comparison with that in ampere hours at different rates.

Efficiency.—At Lyons, for a period of one month, the efficiency obtained by measuring with a watt meter the energy spent in charging, and the energy drawn out from the battery, was over 85%. In Hanover the efficiency of the battery for one entire year, measured the same way, was 78.4%. At Dessau, Germany, the efficiency for a year was 78%. In the 53d St. station the watt hour efficiency has been over 85%, the percentage which was guaranteed by the Crompton-Howell Co. It is conceded by all authorities that an efficiency of 75% can be expected of such batteries, and that under normal conditions it may reach 80% or more.

It is proper to distinguish between the station efficiency and the battery efficiency, for a battery loss of 25% does not necessarily mean a loss of 25% of the whole power. If the battery, as in most cases, supplies only one-fourth or less of the whole output (in watt

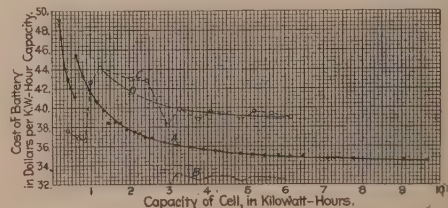


Fig. 5.—Cost and Capacity of Storage Battery Cells of Various Types.

hours) it is that portion alone which the loss of the battery affects. Even in Hanover, where the proportion of the battery output is comparatively high, 53.5% of the whole, the total loss entailed by the battery is only 9.4% of the whole energy produced by the plant.

Initial Cost.—Your committee has found it very difficult to secure complete data as to the initial cost

of central station batteries. The cost is relatively greater for small cells than for larger ones, since the cost of the containing vessel and of setting up the cell does not decrease with the size.

In Fig. 5, the curve A shows for the different sizes the list costs per kilowatt hour capacity of Tudor batteries, f. o. b. at the works, including packing. The discount allowed could not be ascertained with precision. The curve B shows the cost of Crompton-Howell batteries erected in London, the cost of erection being about 10%. The curve C is the same cost, with 20% added, which is estimated to be the approximate cost delivered and erected in New York. The dotted average curve D is added for convenience of comparison with A. The irregularities in the curves B C are due to the transition from one type of plate, and also to the cost of containing vessels, which varies irregularly.

The Electric Storage Battery Co., of Philadelphia, which is about to put on the market some large central station cells (up to four kilowatt hours) of a type already in extensive use in France, informs me that it expects to reduce the cost to \$25 f. o. b. per kilowatt hour capacity. The total cost, erected, would be from \$30 to \$35, according to distance, etc. The cost of imported batteries, erected, would probably range, according to size, from \$40 to \$65 at the present time.

Maintenance.—The maintenance is generally guaranteed by the manufacturer for a fixed annual percentage. At first this percentage was as high as 10%. It was found, however, as the result of improvements, that this percentage could be reduced safely. The present ruling cost of maintenance is about 5% per annum for a 10-year guarantee. In every case it is stipulated that the battery will be put in as good condition at the end of 10 years as when first installed.

Mr. W. S. Barstow, superintendent of the Brooklyn Edison station, who visited several battery stations in Europe, has informed me that in some instances the lighting company has found that it could itself undertake the maintenance and effect a saving, which fact he was allowed to verify by access to the accounts, the cost being in some cases as low as 4% for a period of several years. The Tudor battery, installed in the Edison section already referred to, is stated to be under a 10-year guarantee at 3.5% per annum. There being no instance of a storage battery used in railway stations, the cost of maintenance under conditions which obtain there cannot be ascertained, and can only be conjectured. It would appear, from the consideration of the new conditions involved, that the depreciation must necessarily be greater, and that not less than 12½% or even 15% should be taken provisionally as the estimated cost of battery maintenance in railway power stations.

Conditions of Use.—Your committee has noted in every case investigated a scrupulous attention to details large and small, of the installation of the batteries, and of their care and treatment, which contrasts greatly with the way storage battery installations have been usually treated in this country. This may, and doubtless does, account in part for the difference in results obtained. Great care is taken to have the battery perfectly insulated, and to see that the plates are equally spaced, equally formed and equally active. The purity of the water and of the acid used is carefully watched, the strength and quantity of solution is carefully regulated, and, finally, care is taken that the battery is properly and fully charged. Some form of watt or coulomb meter is always used as a means of determining the efficiency, and often as a means of controlling the amount of charge to be put in.

Service Performed.—The gain resulting from the use of storage batteries may consist in a saving of initial cost, of labor, or of power, or it may take the form of an increased revenue that could not be obtained otherwise. The saving in initial cost is often the principal object aimed at. The saving of labor is, in some cases, an important consideration. There are many cases, such as the Kensington Court sub-station, in London, where the plant is shut down, the station locked up and the load taken care of entirely by the storage battery for several hours; about six in this case. The gain from increased revenue by the use of storage batteries is effected in cases where the supply of power is continuous but limited, usually water power, but also in the case of gas engines which, it may be said by the way, are coming into use in central stations in Europe, particularly in Germany.

Application to Electric Railway Power Stations.—The abundant evidence which your committee finds of the usefulness of storage batteries in central stations for electric lighting make it natural to presume that they can also render a good service in electric railway power stations. Your committee had hoped to be able to present at this meeting some practical results tending to show whether or not this presumption be warranted, but no amount of argument or persuasion has availed with the street railway managers who were approached, so great is the disrepute into which the storage battery has fallen in this country.

The object aimed at is the same in this case as in

lighting stations—economy, especially of initial cost and of power. The conditions which the storage battery must meet, however, are scarcely the same; they even vary considerably in different cases, especially according to the size of plant. The problem is to determine what the power will cost with and without the use of a storage battery in any case. The initial cost of the storage battery will primarily depend upon two things: First, the total maximum quantity of energy it will ever be called upon to deliver, its storage capacity, say, in kilowatt hours; and second, the maximum rate taken in any convenient unit, say kilowatts, at which the energy will be put in or drawn out. Sometimes one of these factors, sometimes the other, alone, and sometimes both together will influence the size of battery to be used for a given case. Your committee has found it convenient to designate these as the "battery factors," calling the first the battery "quantity factor" and the second the battery "rate factor," in which case they are expressed as ratios. Thus the quantity factor is defined as the ratio of the quantity of energy to be drawn from by the battery to the total quantity to be furnished to the trolley circuits under maximum conditions, while the rate factor is defined as the ratio of the current to be furnished by the battery to the total current, also under maximum conditions.

There are also the station factors to be considered, a most important one among which is that to which an eminent English electrical engineer, Mr. B. E. Crompton, has given the name of load factor. If, in Fig. 1, we take the dotted line to represent the mean or average load at which the plant, when worked constantly for the total run, would develop the same total amount of energy that is represented by the load curve itself; and if we draw another line higher across the diagram, to represent the mean or average load which the station plant could carry, when worked for the whole run at its full normal capacity, then the ratio of the height of the first line to the height of the second line is the "load factor" or the relative proportion of the actual output to the possible output or earning capacity of the station.

If in Fig. 1 we take 2,200 HP. as the total capacity of the station (although it is in reality higher at Minneapolis), then, since the mean load, A B, is 1,168 HP., we find for the load factor the value of 53.2%, which translated into business language means that the plant has only 53.2% of the earning power it ought to have for its size and for the interest and depreciation which has to be paid for it per annum. The smaller the power station, as a rule, the smaller this load factor, and consequently the greater the proportion of "idle" capital investment. This is not the worst feature of the situation. The loss of economy entailed in running machinery at lower capacity which is notable even when said light loads are constant, becomes serious when they are also fluctuating to the extent that obtains in railway plants. Under those conditions the engine is not quietly, but openly, "knocking down" on the coal pile, so to speak.

Let us take for instance the load diagram in Fig. 1, which shows by calculation a total output for the day of 23,260 HP. hours. Actual tests made at this station* show a steam consumption of some 21.51 lbs. per HP. hour, with compound condensing engines that would easily do the same work with 16½ lbs., or 5 lbs. less, if doing this work at a uniform rate. Here then is a case where the highest engineering skill and material have apparently been used, with a view to securing the highest economy; where, in a word, the conditions are probably more favorable than in three-fourths of railway power stations, taken as they come; and yet the fuel consumption is still some 30% greater than might be. This means for the whole output of the day 116,300 lbs. of water to be evaporated, equivalent, as the boiler tests indicate (9.8 lbs. steam per lb. of coal) to 5.3 long tons (2,240 lbs.) of coal.

Your committee finds in the same paper some valuable corroborative evidence of the great influence which the character of load has on the efficiency of the engine. In a station where the steam consumption was found to be 29.2 lbs. per HP. hour under the conditions of the actual service, the authors found it was only 22.5 lbs. when the same engines were on a steady constant load which they specially provided and arranged for the test. The compound engines in this case were of a type claimed to be more efficient than most others under fluctuating loads; yet the steam consumption on fluctuating loads is still about 30% higher than it would be on steady loads.

We must first determine the battery factors. In railway power stations the rate factor will usually be much larger and the quantity factor much lower, relatively, than in lighting stations. Hence the size of battery required is more apt to depend on the rate factor, while in the case of lighting stations the reverse is usually the case.

It may happen, indeed, that although the actual capacity needed is quite small, a larger battery must be

used, nevertheless, simply because the smaller one could not be charged or discharged at sufficiently high rates. In lighting stations, on the contrary, if the battery has the capacity, its rate factor is generally adequate for the case. As the extreme rates of charge and discharge would be momentary, lasting from a second to a few minutes, in batteries used on railway circuits, a much greater latitude could doubtless be allowed in this respect. Taking the current rate for seven-hour discharge as normal, it is the opinion of your committee that these rates could be safely doubled for short periods. Provisionally, however, a rate corresponding to four-hour discharge may be taken. This establishes a relation between the rate factor and the quantity factor, for, in order to be able to count upon a certain rate of delivery we must provide a capacity sufficient in every case to maintain this rate for four hours. Hence, given the rate of delivery in kilowatts, the battery capacity in kilowatt hours must be four times that number; or given the capacity, the highest allowable rate will be one-fourth that number.

In Fig. 1 the line A B represents the load which the engines would carry to do the same work at constant and uniform rate, working 20 hours per day instead of 22. This mean load is 1,168 HP. For 22 hours it would be about 1,057 HP. In order to be able to run the plant continually at either rate the battery must be adequate in capacity and in rate to supply all the power necessary when the "waves" rise above the mean load, and it must be capable of absorbing all the energy required to keep the load up when the waves or "billows" fall below it, especially at the beginning and end of the run. It is easily shown that under such conditions the annual cost of the battery would be greater than the annual value of the gains derived by its use. Let us see if the conditions can be varied slightly so as to reduce the cost of battery and still retain its advantages as a load equalizer and compensator. We will assume that the plant is to be run 20 hours per day, two shifts of ten hours, starting from 5 a. m., with about 800 HP., and running for an hour, then running from 7 a. m. until 10 p. m., at 1,300 HP.; then running again at 800 HP. until 1 a. m., the end of the run. The cars running after the plant stops, or during the night, and those running before the plant starts would draw their current from the storage battery, a feature not without its merits. When the plant started at 5 a. m., it would deliver some 500 HP. into the batteries. By 6 a. m. the lines would absorb about the whole 800 HP., and consequently the generating output would be raised to 1,300 HP., which point the load soon reaches, so that by 6:30 the battery has not only stopped charging, but has even discharged for several minutes to take care of the excess of load above 1,300 HP. From that time until about 5:30 p. m. the battery is ebbing and flowing, the difference between the total amounts of charge and the total amounts of discharge being very small. About this time, however, the battery would begin to discharge, and by 6 p. m. it would be carrying a 450-HP. load, that being the excess of total load (1,750 HP.) above the engine load, which, as stated, is to be kept constant at 1,300 HP. At 9 p. m. the load falls under 1,300 HP., and the battery begins to receive a charging current again. From 10 to 12 p. m., the output being reduced to 800 HP., the batteries will, as the curve indicates, charge and discharge in turn. From 12 to 1 the batteries will be mostly charging.

The quantity factor, by calculation, is some 6%; or if we selected the battery by this factor it would leave a capacity of 6% of the total daily output, 23,260 HP. hours, which is about 1,400 HP. hours. The rate factor is about 27.8% of the maximum rate taken at 1,800 HP. This is 500 HP., and at the least capacity will be four times that number, or 2,000 HP. hours. Therefore the battery factor compels us to take a capacity some 43% greater than the quantity factor shows to be actually needed. This means that in practice the battery will not be discharged fully at any time except in emergencies, for which it has a reserve sufficient to carry a load of 500 HP. for over an hour.

A capacity of 2,000 HP. hours is theoretically equivalent to 1,492 K.-W. hours; but as 1 HP. hour at the engine would represent not over 0.85 electrical HP. hour, it follows that the practical equivalent capacity of battery is 1,275 K.-W. hours. Taking the cost purposely at the highest figure, \$0.65 per K.-W. hour, the initial cost of the battery, of say 1,300 K.-W. hours, erected, will be \$8,450. The depreciation at 15%, and interest at 6%, or in all 21%, will make the annual cost \$1,775, or \$4.80 per day for a year of 365 days.

The estimated saving for this case in consequence of making the load steady was equivalent to 5.3 tons of coal. The battery, however, will add, to the total energy produced, enough to cover the energy loss which it introduces. The battery supplies 6% of the energy at a loss of 75%, which means 4.5% of the whole energy produced. The plant will therefore have to generate some 24,380 HP. hours instead of 23,260, representing 18,315 lbs. more steam and 1,869 lbs. more coal. The net saving would therefore be about 4.47 tons. In a station already built, such as this one, the

*"Performance of Street Railway Power Plants," by W. A. Pike and T. W. Hugo, read at the International Engineering Congress, at Chicago, Aug. 3, 1893.

only saving is that in coal. If coal cost less than \$1.10 per ton the project would not pay. At \$2 a ton it would effect a saving of \$4.08 per day, and a corresponding amount at other prices.

In the case of a new station, however, the saving would be materially greater, for it would include the interest on a certain capital that is economized in the equipment. Instead of a maximum capacity of 2.2.0 HP., assumed here, the plant need not be built for more than 1,500 HP. capacity to do the same work. We have a saving in the cost of 700 HP., amounting to probably at least \$7,700, the interest and depreciation on which, taken at a low figure, 12½% for the two, amounts to \$962 per year, or \$2.64 per day.

In many cases the problem is slightly different. The road has developed and extended until the power station capacity is overtaxed. In many such instances calculation based on a full study of the conditions involved would probably show that the increased capacity could be obtained more cheaply by simply adding a storage battery to the station, the fact being that the station capacity is large enough when once the fluctuations are disposed of. In many such cases it would doubtless be found that, owing to the gain in efficiency, the cost of power would not be much increased, if at all; and in a few cases where the efficiency is now desperately low, it might even cost less for more cars.

Your committee has selected the example given above for a detailed case, first because the data obtainable regarding it are more complete than for any other case; second because it has been always considered that a road of 150 to 200 cars was a limiting case, where the storage battery was likely to be of little, if any, utility.

The smaller the station, the more perceptible the effect on the efficiency will of necessity be. The quantity factor becomes smaller, but the rate factor is usually larger, until on small roads of ten cars and less it may amount to 60%, the load itself sometimes running up to 2½ or 3 times its average value.

Water Power.—The use of storage batteries is destined to important application where water power is used for railway power generation. In such cases, since the power costs relatively little, the gain in efficiency is not of so much moment as are the regulating quality and the ability to store energy. Where the supply of power is constant but limited, the rate of consumption can never exceed the rate of production. The consequence is that in railway water power stations either the potential fluctuates seriously or else a sufficient margin of available power must be allowed; which means that the power cannot be worked to the limit. With the storage battery not only may the turbine be loaded to the full limit, but the load may even be greater, if there is sufficient time in the interval between heavy loads, to accumulate a reserved power in the batteries.

Sub-stations.—It makes little or no difference in the compensating action of the batteries whether they be coupled to the circuit of the station or at sub-stations located at various points at a distance from the station. There would result from the use of sub-stations a greater uniformity of potential over the whole system, and a saving in copper; but one must offset against this the extra cost of the space, the extra attendance and expense of substations. They may be warranted, for this reason only, in very large systems covering large and relatively distant territory, also in inter-urban lines.

Conclusions.—The investigation and study of the facts and data bearing on this subject as outlined above would seem to warrant the following conclusions:

(1) Great progress has been made in Europe during the last two or three years in the manufacture and perfection of storage batteries suited for central station purposes.

(2) Storage batteries have been introduced in a large number of electric lighting central stations on a large commercial working scale, as factors of reserve and regulation, with a view to securing economy of initial cost and cost of operation, with satisfactory financial results, as a general rule, which has few, if any, exceptions, so far as your committee could ascertain.

(3) The benefits derived from central lighting stations from the judicious use of storage batteries are so valuable in individual cases that the possibility of attaining like benefits, even to lower degree, in railway power stations would justify the investigation of their use by actual experiment where this can be done under favorable conditions.

(4) While the conditions differ, and are essentially more severe, in railway power stations, there is no reason apparent why storage batteries may not be used successfully and advantageously, for the purpose of securing greater uniformity of potential at the station or on the line, or of promoting and improving the efficiency of the plant.

(5) Even assuming the highest values for initial cost and depreciation of the storage batteries, the indications point to the possibility of realizing a gain in economy in all stations operating 200 cars and less,

when coal is worth \$2 per ton and over, while the economy will be much greater should the initial cost and depreciation prove actually lower in practice. Advantages are also secured which, though not effecting economy directly, do so indirectly by affording additional convenience in operation.

(6) The indications are that in some cases a power plant could be built and operated at less cost by using storage batteries than without.

(7) The capacity of an existing plant can probably in most cases be increased more cheaply by adding storage batteries than by adding more generating machinery, while at the same time the cost of operation will be reduced.

(8) The question whether the storage batteries are expedient and practicable, and to what extent, in any particular case, should be, and can only be, in the present state of our knowledge, determined for each case individually, by a careful analysis of the facts and conditions involved, by a competent engineer.

(9) Practical experience in a certain number of stations alone can lead to definite rules or indications in regard to the best size of the battery, the best methods of regulation, the most favorable conditions of use, and like questions.

THE TOWER OF THE NEW CITY HALL AT PHILADELPHIA, PA.

The following is an abstract of a paper by C. R. Grimm, to be presented at the meeting of the American Society of Civil Engineers, on Nov. 15. The hoisting plant for the great tower was illustrated and described in our issues of July 2 and 9, 1887. The abstract is reprinted from the Society's bulletin:

It has long been the practice to construct domes, conical roofs, etc., supported by a number of trusses occupying planes radial to the vertical axis of the structure. J. W. Schwedler conceived the idea of designing the wrought iron "mantle construction" which bears his name, in which the stresses occur and are taken up in the mantle of the structure, leaving all the interior space clear. The literature upon this subject is as yet scanty, and since the ironwork of the new city hall at Philadelphia is of this kind, the writer desires to give an account of it to the society.

Up to a height of 337 ft. the tower is of brick, faced with marble, and is now about complete. To avoid excessive pressure upon the foundation, the commission decided to construct the remaining portion, 173 ft. in height, of metal. The contract was awarded to the Tacony Iron & Metal Co., Tacony, Pa., the author being placed in charge of the designing. The framework rests upon granite blocks and consists of an octagonal prism, surmounted by an octagonal pyramid of the same diameter. This wrought iron framework may be divided into a primary and secondary construction, the former being the true skeleton, while the latter forms the direct support of the shell and transmits to the former the wind pressure upon it, and, in the case of the pyramid, its weight also. The weight of the shell of the prismatic portion is carried by the secondary construction directly to the masonry of the tower. The inside diameter of the octagon is 49 ft., outside diameter 53 ft.; inside diameter of the octagon at the top of the pyramid is 4 ft. 6 ins., and the outside diameter 10 ft. 10½ ins. The height from the top of the granite to the connection with the prism and pyramid is 67 ft., and from the latter point to the top of the tower cap 104 ft., which latter will receive the colossal bronze statue of William Penn, 37 ft. in height; making a total height, from the ground to the top of the statue, of 547 ft. 7½ ins.

The primary construction is divided into ten stories, three for the prism and seven for the pyramid, and consists of eight rafters forming the corners of the pyramid and eight columns forming those of the prism, together with the octagonal braced rings and the diagonals. A panel is comprised between two rafter sections of the pyramid (or two column sections of the prism), and two ring sections, one above the other, and each is crossed by two diagonals, designed for tension, those for the top stories being for compression also. The eight columns of the prism rest upon four wrought iron box girders, 24 ft. 4 ins. long. The girders rest lengthwise upon cast iron wall plates, 3 ft. x 11 ft. x 2½ ins. The box girders project, therefore, 6 ft. 8 ins. at each end, forming cantilevers of this length. The columns of the prisms are supported by these projecting arms, 4 ft. 8 ins. from the ends of the wall plates. This peculiar construction is made necessary by the character of the supporting masonry.

The wind bracings consist of two sets of horizontal tension members, acting with the compression members, which form the octagonal ring at the top of each story. Since the feet of the columns in the prism are anchored to the box girders, the wind bracing is not there required. This horizontal construction allows only such deformations as are due to the elasticity of the material. This form of bracing was required by the necessity of a spiral staircase within the tower,

reaching from the top of the stone tower up to the balcony. The secondary construction consists of four skeleton columns 56 ft. 9 ins. high, and four arches about 36 ft. 3 ins. span, together with three octagonal rings and 76 vertical posts between them. The secondary construction of the pyramid consists of octagonal rings which support the jack rafters. All floors are carried by the tower framework, the first at the top of the prism, the second at the middle of the sixth story, the third at the top of the seventh story, from which latter a door leads to the balcony.

The weight of the prism shell is carried to the masonry independently of the primary construction; its wind stresses are carried to that construction by horizontal rigid connections. All rafters of the pyramid and all columns of the prism have two web plates and four angles; and only in the case of the bottom column has a cover plate been added. The tie-rods of the wind bracing are pin-connected. The diagonals are pin-connected to the struts. All tension members are connected by either clevises or single eyes with open turnbuckles. The main and lateral pins are of steel. The aim has been to design all details centrally, and when a bending moment is thrown on a member in addition to the stress due to its position as a member of the structure, such member has been proportioned to resist both.

The tower shell is of cast iron. The louvers of the pyramid are of steel plates ¾ in. thick, to save weight. In order to avoid the great expense of keeping the iron work painted and free from rust, the shell of the tower is electroplated with copper, and it is to be given a finished coat of aluminum. The separate pieces are first boiled in a strong solution of caustic soda, then washed with water from a hose, and then pickled with sulphuric acid until all rust is dissolved. They are then cleaned with steel brushes and water, and are ready for plating. The total thickness of the metallic coat is from 1-32 to 1-16 in. The statuary work will all be of bronze, composed of 88 parts of copper, 10 parts of tin and 2 parts of zinc, and will have an average thickness of ¾ in.

The scaffolds to be used in the erection of the tower are now all complete, with the exception of that to be used in the erection of the Penn statue. Owing to the complicated nature of the structure, all the work was erected in sections in the company's yard. In the final erection the shell will be made water-tight by the use of "usuduran." Brass bolts with counter-sunk heads on the outside will be used for the shell. A timber platform about 100 ft. square, with the corners cut off, has been provided for erection, and as a protection against accident, this is provided with a rail, and wire netting 8 ft. high. For the erection of the four lower stories of the pyramid a different scaffold is provided. This will be carried by the eight cantilevers of the first floor, and carries at its top a revolving derrick. The tower-shell will be put in place after the erection of the statue at the summit.

The tower has been proportioned to carry the following loads, namely: Its own weight, that of three floors, the balcony, the secondary construction, the shell of the pyramid and the statue. The secondary construction carries its own weight and the greater part of the shell of the prism, four statues and four eagles. Each of the three floors and the balcony are proportioned to carry a load of 100 lbs. per sq. ft. Wind stresses have been calculated for a pressure of 50 lbs. per sq. ft., supposed to be acting horizontally against the shell, the surface of which for this purpose is regarded as vertical throughout, while the prismatic part of the tower has been treated as a four-sided prism whose width equals the full diameter from out to out of the shell. To avoid an increase of wind pressure the shell will not be placed until after the removal of the scaffolding.

The minimum thickness of wrought iron is ¼ in., and in some cases it is 5-16 in. Field riveting is to be avoided, and turned bolts with a slight taper are to be used instead. All tension members are tested to a stress of 20,000 lbs. per sq. in. In determining the wind stresses in the various members of which the tower is composed, it is considered to be a cantilever fixed at the bottom. The total estimated weight for the tower is 1,000 tons. The total wind pressure amounts to 183.7 tons. The approximate area of the tower shell is 57,000 sq. ft., and the tower is believed to be the heaviest ever erected in metal at such an altitude.

An interesting note is added, giving a table showing the horizontal deflections of the masonry tower under the influence of the sun, determined by readings taken three times a day excepting Sundays, and covering a period of one year; showing also the maximum, minimum and average temperatures each month, taken at a point inside of the tower, 230 ft. below the top. Deflections were measured by a plumb line of this piano wire 230 ft. long, with a heavy weight suspended at the bottom. The frame rests on a wooden box containing molasses into which the weight is dipped. The maximum measurement in the north and south direction was 9-32 in. and in the east and west direction 5-32 in.

UNDERGROUND FEEDERS FOR ELECTRIC RAILWAYS.

A paper on the above subject was prepared for the recent convention of the Street Railway Association, but its author, Mr. Dugald C. Jackson, was unable to be present, and the paper will be printed in the proceedings. The author classes underground construction under the heads of "built-in" systems and "drawing-in" systems. The built-in systems have been used to some extent, and with fair success, but their use is not generally advisable. In the "drawing-in" system, the ducts, into which the insulated and protected conductor is drawn after the subway is completed, may be made of iron gas pipe, cement-lined iron pipe, burnt clay or terra cotta pipe or of wood. The ducts may be either laid directly in the ground or in concrete. The author said that while some experts claimed that iron pipe laid in concrete (the most expensive form of duct) was the only satisfactory form, experience had shown that iron pipe is not necessary except where obstructions are frequently met and bends in the duct must be made. For light feeder lines he would use ordinary cement or vitrified clay sewer pipe laid in concrete. This costs only two-thirds as much as iron pipe laid in the ground without any protection. A creosoted plank laid on top of the concrete is worth all it costs as a protection from injury by street laborers' picks. Clay ducts must not be laid too near the surface, or they may be crushed by the street traffic. Where very heavy or important feeders are to be laid, iron pipe is the safest reliance.

Manholes for drawing in the cables may be made to cost as much as \$100 each; but for street railway feeders small holes, costing less than half as much answer very well. Feeders should be led from the manhole to the pole supporting the trolley wire through small iron pipes.

The cable, or insulated conductor, to be laid in the duct consists of three parts, the copper conductor, the insulation and the protective coating. For small sizes the conductor may be a single wire, but larger conductors should be of small wires stranded, to secure flexibility. In laying down an extensive feeder system, economy dictates the use of one standard size of cable throughout. The insulating materials commonly used are compounds of india-rubber, various waxes, bituminous substances and oils. The rubber compounds are usually applied directly as a covering to the wire, but the less staple bituminous compounds require some absorbent for a basis. This should be strong, soft and flexible, with little fuzz, and be a good insulator when dry. Cotton, paper, hemp and jute all serve in this capacity. Cotton probably answers the requirements best, though paper is an excellent and inexpensive insulator, and when the cable is made properly it serves admirably. Unless the compounds used with paper serve to soften it, however, the paper is likely to crack and cause trouble.

No cable with a fibrous insulation can be made moistureproof, so the wire with its insulation must be inclosed in an airtight sheath. This not only serves to exclude moisture, but gives protection from gases, acids, etc., and from mechanical injury in handling and drawing in. This outer sheathing is invariably made of lead, and great care must be taken that no flaws exist in it, as a single pin hole may cause the destruction of a considerable section of the cable. Rubber insulation should always be used in preference to fibrous when a cable is to be submerged, notwithstanding its greater first cost.

The lead covering may be injured mechanically in drawing in, or corroded when in the ducts by chemical action. The first evil can be guarded against by good conduit construction. Corrosion of the lead is due usually to alkalis, although in Boston the telephone cable coverings were eaten off by the electrolytic action of the railway return current. An electric railway, however, should not fear much from its own return current, as connecting the lead to the rail at intervals, will dispose of the current without much chance for electrolysis.

The joints are the weakest points of any underground system, and should be made only by men of reliability and long experience. A sleeve of lead should be put over the joint and wiped to the cable sheath on each side. Wherever a connection is

made from a cable to an overhead circuit, a first-class lightning arrester should be placed.

The cost of constructing and maintaining underground systems depends largely on the number of wires in use. The cost of maintenance should be small; but it can only be expected to be so when testing is kept up so faithfully and continuously that faults are located and repaired before they become breakdowns. There is no reason why the cables cannot be kept up to an insulation of 1,000 megohms per mile, and the number of breakdowns made to average less than one per mile of cable in 25 years. The cost of maintenance varies inversely with the care in putting down the system and the care in keeping up the tests. It is sometimes claimed that \$5 per mile of cable is sufficient to allow for maintenance on a system of considerable extent, but this figure is not often reached. If properly installed under fair conditions, experience seems to show that 5% is sufficient allowance for depreciation of cables and conduits. The cost of conduits of iron pipe laid in concrete in unpaved streets is, in cents per lineal foot, about 25+24d, where d is the number of ducts. To this must be added the cost of repaving, any charges that may be required on account of special work, and from 12 to 20 cts. per lin. ft. of conduit to cover the cost of manholes. Single ducts of sewer pipe may be laid for about 35 cts. per lin. ft., not including manholes or repaving. Wooden conduits may be made to cost less. The cost of cables depends on the size of the conductor, the thickness and quality of the insulation, and the thickness of the lead. A No. 0000 cable, with insulation about 5-32 in. thick, and covered with 3-32 in. of lead, may be ordinarily laid in the conduits for between 50 and 60 cts. per lin. ft., unless an excessive amount of special work is required. Even for heavy underground lines the annual cost (interest+depreciation+maintenance) is three or four times that of lines of equal capacity placed on good overhead construction.

The New York & New Jersey Bridge bill passed the Senate on Oct. 31, and now goes before a conference committee for action on the Senate amendments. As passed by the Senate the bill empowers the Secretary of War to decide whether a pier may be built in the river or not, and to fix its dimensions if its construction is permitted.

A new through line from New York city to Boston and New England points has been so often announced, and has so invariably failed to materialize, that the public will be inclined to take with some grains of allowance the announcement of Mr. A. A. McLeod that the New York & New England proposes to build a connection to New York City inside of six months. It was definitely given out, however, after the meeting of the directors of the New York & New England Co., in Boston, on Oct. 31, that President McLeod had been authorized to make traffic contracts with the New York, New England & Northern (the corporation which is to construct the proposed extension) and with the Manhattan Elevated, also for the construction of a railway between Mill Plain, near the New York state line, and New York City. It is stated that the Ryan & McDonald Construction Co. will build and equip the new extension.

The Corinth Canal, says U. S. Consul George Horton, of Athens, will abridge by 185 nautical miles the route of vessels bound from the Adriatic to Constantinople, and will save 95 miles in the case of vessels bound from Mediterranean ports. As before stated in these columns the canal was commenced in 1881 under a concession granted to Gen. Turr by the Greek government; but the original company having failed another was formed with French capital and the canal was officially opened on Aug. 6, 1893. The present company has a capital of 5,000,000 francs. It is estimated that the annual traffic through the canal will amount to 4,500,000 tons, paying 1 franc from the Adriatic and ½ franc from elsewhere. One franc will be charged for each person on a passing ship. The company's lease is for 99 years, and at the expiration of this term the canal becomes the property of the government on the payment of 5,000,000 francs to the company. The canal itself is 21,441 ft. long, 68.9 ft. wide at the bottom and 70.8 ft. wide at the surface and 26.24 ft. deep.

A 46-million candle power beacon light is to be located near Quimper, France, at a projecting headland bearing the name of Penmarck. This enormous intensity of light is said to be obtained by an arrangement

of the lenses of the lamp. In the ordinary lamp the lenses, consisting of a number of rectangular panels, are placed in steps in such a manner that the source of light occupies the principal focus of each of them. The rays of light then emanate from this part of the apparatus in a horizontal pencil. By reducing the number of panels, the quantity of light received by each is consequently correspondingly increased. At La Heve there are four panels, the total light emitted by the lamp being triple the amount received in an apparatus with twelve panels. It is proposed in the new lighthouse to employ but two panels, each of them occupying a half square. Each lens will, therefore, receive half of the total light emitted by the lamp, and consequently will emit a pencil of rays of a power double that furnished at La Heve. Like the lighthouse at La Heve, the new lighthouse will be lighted by electricity. The lamp will be fed by an alternating current of 100 amperes at its maximum.

The comparative cost of 50, 300 and 500 HP., by steam and electricity, is given as follows in a report by U. S. Consul J. C. Monaghan, of Chemnitz, Saxony:

	50 HP.	300 HP.	500 HP.
Steam, England.....	\$24.24	\$12.58	\$9.88
" Germany.....	19.21	15.52	13.51
" Bohemia.....	27.50	14.71	12.97
" Switzerland.....	46.82	29.61	25.54
Electricity, Switzerland, at station.....	30.88	16.98	12.54
Electricity, Switzerland, transmitted 3.1 miles.....	57.68	31.27	25.48

Mr. Monaghan argues from the above table that electricity cannot yet compete with steam, though Switzerland has wonderfully developed its water powers for a prime motor and the methods of transmission. As here shown electricity is only a little cheaper than steam in a 500-HP. plant.

Portland cement and metal lath are proposed to replace the staff on the buildings around the Court of Honor at the Columbian Exposition. The Northwestern Expanded Metal Co., of Chicago, made a formal offer to the South Park Commissioners to replace the staff on the Manufactures, Electricity, Administration, Mining, Agricultural and Machinery buildings, also on the Music Pavilion and the Casino with the connecting Peristyle, with a covering of Portland cement laid on expanded metal lath, and whitened, the present decorations being reproduced. The company offer to do the entire work at their own expense, provided they are permitted to inclose the space and charge an admission fee of 25 cts. for a period of 20 years, one-half the gross receipts to be paid over to the Park board after the company is reimbursed for its expenditures.

The dams in the Illinois River which the Federal government is just completing to improve slack water navigation are objected to by the Illinois State Board of Canal Commissioners, which asks their removal. The commissioners say:

The drainage canal now in process of construction will bring to the headwaters of the Illinois, in the near future, 600,000 cu. ft. of water per minute. To this immense volume of water the dam will be simply an obstruction. The General Assembly of Illinois, by act of 1893, has already provided for the removal of the dams, which are under state control, namely those at Henry and Copperas Creek, as soon as it will be made necessary by the completion of the drainage canal. Since this action of the General Assembly, the National government has nevertheless expended about \$200,000 more upon the dams under its control. In view of the foregoing, we desire to respectfully submit that whatever money is hereafter appropriated by Congress for the improvement of the Illinois River should be expended for the purpose of dredging and deepening the channel of the river, especially with a view of utilizing the increased volume of water that it will eventually receive upon the completion of the canal, and that for such purposes liberal appropriations should be made, and that it would be desirable for Congress to take such action as may be thought best for the final removal of the dams now under control of the National government from the Illinois River.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago—Existing Roads.

ANNAPOLIS & BALTIMORE SHORT LINE.—The U. S. Circuit Court has directed the Safe Deposit & Trust Co. to sell this road at public auction. The line extends from Annapolis, Md., to Baltimore, 28 miles. Receiver, Charles A. Coombs, Baltimore, Md.

BALTIMORE & OHIO.—It is reported that Drake & Stratton, Pittsburg, Pa., and New York, who are building the Fairmount, Morgantown & Pittsburg road, are about to award the contract for a short branch to be built from near the mouth of Indian Creek to Normalville, Pa. The Fairmount, Morgantown & Pittsburg road is expected to be opened for traffic as far as to the Cheat River, beyond Point Marion, Pa., by the middle of this month.—The Commissioners of the District of Columbia have unanimously approved a bill now before Congress requiring this road to enter Washington by an elevated viaduct along Delaware Ave., the changes to be made before Jan. 1, 1897.

BUFFALO & SUSQUEHANNA.—The extension of the Shannemahoning Valley R. R. from Costello, Pa., to Galeton, a distance of about 35 miles, has been completed, and will soon be opened for traffic. This is one of several roads being built in Potter county, Pa., by F. H. & C. W. Goodyear, Austin, Pa., to develop about 200,000 acres of timber land, and it is stated that the various lines will soon be consolidated under the above name.—Surveys are being made for an additional extension, according to reports.

LOUISVILLE, EVANSVILLE & ST. LOUIS CONSOLIDATED.—This company is contemplating several extensions in Indiana. Ch. Engr., T. A. Allen, Evansville, Ind.

MONTREAL & WESTERN.—The completion of this railway to Chute aux Iroquois, in the county of Ottawa, was inaugurated last week. The road is now in operation from St. Jerome to that place, a distance of 70 miles, and the extension was completed several weeks ago, as stated in a communication from G. H. Garden, Ch. Engr., St. Jovite, Que., published Aug. 3.

NEW YORK & NEW ENGLAND.—It was announced at the meeting in Boston, Oct. 31, that the contract for the construction of the proposed New York, New England & Northern road, to give this line an entrance to New York, and thus a direct line between that city and Boston, has been awarded to the Ryan & McDonald Construction Co., Baltimore. It is reported that contracts have also been awarded for equipment and terminal facilities, and that the new road will be built at once.

NEW YORK, NEW HAVEN & HARTFORD.—Bronson Bros., Westfield, Mass., are reported to have received the contract for building a double track on this road from South Norwalk, Conn., to New York, the work to give employment to about 100 men and to be completed within a year.

Projects and Surveys.

PATH VALLEY NARROW GAGE.—Incorporated to build a railway 16 miles long from Germantown, Perry county, Pa., to Dry Run, Franklin county, Pa. The road, according to press reports, will be an extension of the Sherman Valley road, in Perry county, and will require a 400-ft. tunnel. One heavy grade will have to be established. The road will start from East Waterford, Juniata county, and the ties will be laid large enough for a broad gage if a change is ever desired. Engineer Moorehead has sent to Dry Run a lot of machinery to be used in grading. It is probable that the South Penn branch of the Cumberland Valley R. R. will be extended from Richmond to Dry Run to connect with the new road and thus give the Pennsylvania R. R. west of Harrisburg a shorter route from this valley.

Southern—Existing Roads.

ABBEVILLE SOUTHERN.—This road will probably be opened for traffic to Abbeville, Ala., this month. The southern terminus is about six miles from Dothen, Ala., on the Alabama Midland Ry., and the construction work has been under the charge of Bradford Dunham, Gen. Supt. Alabama Midland.

ATLANTIC COAST LINE.—A press report from Columbia, S. C., states that the extension of this railway near Sumter, to Denmark, with a view to establishing a competing short line through to Florida to the Richmond & Danville-South Bound combination, is being much more rapidly constructed than many suppose. Most of the grading has been completed. This branch will cross the track of the South Carolina Ry. at Orangeburg, and the new track will go under the South Carolina Ry. The trestlework which will support the South Carolina Ry. track has been completed. The rock for the piers of the bridge across the Santee River is being gotten out at Columbia and is being hauled to the Congaree River, where it is loaded on steamers and taken to the place on the Santee River where the bridge will be erected.

CONDON LANE BOOM & LUMBER CO.—This company has about 300 men at work on a railway from Hendricks, W. Va., to the headwaters of the Granby River, in Randolph county. The road is intended to open up timber land and is being built in connection with the West Virginia Central & Pittsburgh R. R.

MONTGOMERY, TUSCALOOSA & ST. LOUIS.—This company has arranged to issue bonds for \$3,500,000 to build the line from Montgomery, Ala., to Columbus, Miss., referred to last week. It is reported that the entire road will be constructed by J. W. Woolfolk & Co., and will be operated by the Mobile & Ohio.

NORFOLK & WESTERN.—The Dingess branch, on the Ohio River extension in West Virginia, is reported as about to be extended several miles to other mines and timber camps.

ROARING CREEK.—This railway is being built from the West Virginia Central & Pittsburgh R. R. in Randolph county, W. Va., down the valley of Roaring Creek, about ten miles, to extensive coalfields. The work of grading is well under way and a large force of men is now at work on a bridge over the Tygart River below Harding station. Jas. F. Potts is the contractor.

WHEELING & ELM GROVE.—A two-mile branch has been built at Fulton, W. Va., connecting with the Baltimore & Ohio and the Wheeling Bridge & Terminal railways.

WHEELING BRIDGE & TERMINAL.—It is reported that work has been resumed on the extension from Wheeling, W. Va., to Benwood. The principal work now under way is a heavy trestle about two miles long which will carry the line from the lower part of Wheeling almost to Benwood. The extension will probably be completed by spring.

Projects and Surveys.

TENNESSEE CENTRAL.—Cumberland county, Tenn., has voted to issue bonds for \$50,000 to aid the construction of this railway through the county, and private parties in the county have subscribed \$25,000. Roan county will vote on a subscription of \$150,000 on Nov. 25. Pres., Jere Baxter, Nashville, Tenn.

MARYLAND.—A local paper states that surveys will soon be made for a railway to Delta, Pa., and that the money necessary to build the road has already been pledged. W. J. Taylor, receiver of the Pennsylvania portion of the Baltimore & Lehigh R. R., is interested.

Northwest—Existing Roads.

DULUTH, MESABI & NORTHERN.—The Lake Superior branch of this railway, about 16 miles in length,

connecting Ore Junction, now called Wolf, Minn., and the Lake Superior mines, at Hibbing, has been completed.

ST. CROIX & DULUTH.—The Empire Lumber Co., Eau Claire, Wis., is building this railway near Grantsburg, Wis., to secure an outlet for 100,000,000 ft. of standing pine. The tracklaying is reported to have been completed for this year.

Projects and Surveys.

MINNESOTA & MESABI.—The Grand Rapids "Magnet" states that as soon as the necessary titles to certain properties can be obtained along the proposed line this railway will be built from Blackberry station, on the Duluth & Winnipeg, to the Diamond mine. It is to be built and operated by a private corporation. The road will start from Blackberry because an easier grade is to be had, and it obviates the necessity of at least eight miles extra haul, which would be the case should the road have been built from Grand Rapids. And the distance from Blackberry to the Diamond mine is much shorter and an easier grade than from any other proposed point.

WYOMING & PIERRE.—Incorporated in Iowa to operate railways and coal mines. A railway is proposed from Minnesota, S. Dak., to ex-Gov. Larrabee's coal mines, 17 miles distant; capital stock, \$450,000; directors, S. W. Gilman, D. G. Scott, A. L. Sweet, I. Clemenson, H. Gilman, L. H. Parker, E. F. Cragin; principal office, Dubuque, Ia.

MISSISSIPPI RIVER & LEECH LAKE.—Morrison county, Minn., has voted a bonus of \$100,000 to aid the proposed railway from Little Falls, Minn., to a connection with the Great Northern at or near St. Cloud. The citizens of Little Falls have already voted to raise \$100,000 for the road. The road is projected by the Weyerhaeuser lumber syndicate.

Southwest—Existing Roads.

CHICAGO, ROCK ISLAND & PACIFIC.—It is stated at Dallas, Tex., that that city and Fort Worth will be given water rates by this company, and that, unless satisfactory trackage arrangements can be made with other lines, a new line will be built by this company between the two cities.

HOUSTON, EAST & WEST TEXAS.—This company has received about 400 tons of steel rails which will be used in extending its steel rail track from the Trinity River. The work of widening the gage of the road will not be commenced at present.

LOUISIANA.—W. Irving Willis writes us from Napoleonville, La., that there are 50 miles of new narrow gage railway within 30 miles of that place, all intended for plantation use. One of the most interesting and best constructed of these is on the Elm Hall plantation of Leon Godcheux, on Bayou Lafourche. It is about 10 miles in length, including sidings, and was built by J. D. Willis, New Orleans. A special locomotive designed to pull 30 carloads of cane, two tons of cane to a car, was built by the Baldwin Locomotive Works for this road, which has a gage of but 2 ft. The Hahnville & Boutte R. R. has just been opened for business in St. Charles parish. The road is 12 miles long, gage 3 ft., and the track laid with 30-lb. rails. Another railway about five miles in length has been built at B. Lehman's Peytevan plantation, near Donaldsonville, and there is contemplated a road from Lockport to Thibodeaux, with L. Godcheux as the principal projector, and still another from Donaldsonville to Thibodeaux to parallel the Bayou Lafourche.

PECOS VALLEY.—Surveys have been made for an extension of this road to South Roswell, N. Mex., and it is stated the extension will probably be built soon.

NEW ORLEANS & NORTHWESTERN.—Press reports state that L. K. Hyde, receiver of this company, has awarded the contract for closing the gap between Rayville, La., and Collins, a distance of 18 miles, to St. Louis parties.

TEXAS, LOUISIANA & EASTERN.—About six miles of track have been laid this year from Springer, Tex., according to reports, and work is now progressing to the Trinity River, a distance of 11 miles. No work will be done east of the river until a bridge has been built. Ch. Engr., W. C. Beach, Conroe, Tex.

Projects and Surveys.

CHOCTAW & CHICKASAW.—Incorporated in Arkansas to build one mile of railway to secure terminal facilities at Fort Smith; capital stock, \$100,000; E. N. Wright, Atoka, Ind. Tex.; Allen Wright, Jas. Brizgola, W. H. H. Clayton, G. E. Kider, R. E. Dubois, Fort Smith, Ark.; N. B. Childs, S. F. Scott, J. A. Atkinson, Kansas City, Mo.

KANSAS CITY, OKLAHOMA & PACIFIC.—Incorporated in Kansas to build a railway from near Coffeyville, Montgomery county, in a southwesterly direction through Indian Territory to Wheeler county, Tex., and thence to Albuquerque, N. Mex., a total distance of 625 miles; capital stock, \$7,000,000; directors, R. B. Field, F. M. Roswell, W. L. Shaw, Wm. McGinnis, Eldorado, Kan.; J. B. Glaze, Wm. Roles, Emporia, Kan.; H. L. McKinney, Albuquerque, N. Mex.

NEW MEXICO.—A press report from Santa Fe, N. Mex., states as follows: For six weeks past a party of 14 surveyors has been engaged in driving the grade stakes for a new railway from Maxwell City, on the line of the Atchison, Topeka & Santa Fe road in Colfax Co., west through the Taos valley, with Creede and Durango, Colo., as their destination. C. L. Betterton, of this city, and James S. Gillen, a pioneer mining man from western Colfax county, conversed with the surveyors a few days ago and Mr. Gillen says that W. D. Cameron, of New York, who is at the head of the enterprise, informed him that the line would surely be built, and that, too, as rapidly as possible consistent with good business methods. On Thursday last the surveyors were near Elizabethtown, headed west. The line goes through Taos Pass to Amizett and thence across Taos valley into Southern Colorado, New York capitalists, who have extensive mining and ranch interests in Colfax and Taos counties, are putting up the money, but as to what railway corporation is back of it, nothing was learned.

OKLAHOMA.—A report from Guthrie, Okla., states that J. W. Burch, of Montana; Wm. Henry, Boston; M. Singleton, Philadelphia; and Frank Drake, Guthrie, are organizing a company to build a railway to the coalfields east of Perry, in the Cherokee strip.

Rocky Mt. and Pacific—Existing Roads.

BURLINGTON & MISSOURI RIVER.—A press report states that work on the extension of this road beyond Sheridan, Wyo., has been indefinitely suspended.—It is also reported that the right of way for further extension through the Crow Indian Reservation, along the southern part of Montana, has all been purchased. The construction of the road through Wyoming has been completed near to the state line of Montana, and it is thought that the work of bridging, grading and changing the channel of the Little Big Horn River will soon be commenced.

GREAT NORTHERN.—Arrangements will be made this winter, according to reports, to commence the construction next spring of an extension up the valley of the Okanoga River to the Okanogan mines, in Washington.

PAJARO VALLEY.—Surveys are being made for an extension of this narrow gage railway from Watsonville, Cal., to Corralitos. This road is operated by the Western Beet Sugar Co. Ch. Engr., W. V. Waters, Watsonville, Cal.

Projects and Surveys.

BIG HORN SOUTHERN.—The Helena "Independent" reports that this company has filed an amendment to its articles of incorporation, stating that the northern terminus of the road is to be at the Yellowstone River, in Yellowstone county. From that point the road is to be constructed across the Crow Reservation, to the valley of the Big Horn River and across the Custer Military Reservation, and up the valley of the Little Big Horn across the south boundary of the Crow Reservation. There is to be a branch beginning on the Fort Custer Reservation, or at some point in the valley of the Little Big Horn.

Foreign.

MEXICAN NATIONAL.—Surveys have just been completed for a branch line 10 kilometers long, starting from a point three kilometers south of Villaladama, Mex. About five kilometers are heavy mountain work. The maximum grade is 4% and curvature about 24°. The terminus of the line is to be connected by 1½ miles of cable tramway with the mountain mines, which are about 5,000 ft. above the Mexican National R. R. at Villaladama. The terminus of the branch line is 900 ft. above the Mexican National R. R. The road will be built by the Villaladama R. R. & Cable Co. and the construction is expected to be commenced next spring. Ch. Engr., Harrison Souder, Villaladama, Mex.

STREET RAILWAYS.

PORTSMOUTH, N. H.—It is reported that the board of trade is trying to secure an electric street railway, and that a company is ready to build it if a franchise can be secured.

SPRINGFIELD, MASS.—The Springfield St. Ry. Co. is planning to build a new power house next year, at a cost of \$125,000 to \$150,000.

TAUNTON, MASS.—The Taunton St. Ry. Co. has petitioned the railroad commissioners for authority to increase its capital stock for extension and changing the motive power to electricity.

WARWICK, N. Y.—It is thought probable that the New York & Greenwood Lake Ry. Co. will build an electric railway between this place and Greenwood Lake.

PLAINFIELD, N. J.—Surveys are being made through this city and vicinity for the projected electric railway from Paterson to Trenton. The line as projected follows the old railway embankment, and will use the track of the Plainfield St. Ry.

NEW BLOOMFIELD, PA.—The Path Valley R. R. Co. has been incorporated with a capital stock of \$90,000.

PITTSBURG, PA.—The Pittsburg, Beltzhoover & Knocville R. R. Co. has been incorporated to build a railway from this city to Beltzhoover and Knoxville; capital stock, \$15,000; Pres., Jas. M. Bailey, Allegheny, Pa.

WILKES BARRE, PA.—Elmer H. Lawall, of this city, is interested in a proposed line to Plymouth; Pres., J. C. Haddock, Glen Summit, Pa.

CULPEPER, VA.—Meetings are being held to secure the construction of an electric railway to Sperryville, Rappahannock county.

MEMPHIS, TENN.—The City & Suburban R. R. Co. is considering an extension to the vicinity of Calvary cemetery. The company has offered to build the line if \$3,000 is subscribed to aid it.

COVINGTON, KY.—The council is arranging with the street railway company for an extension of the line to West Covington.

DUNDEE, ILL.—The Dundee Rapid Transit Co. is reported as planning an electric railway to connect this city and the other river towns, Elgin, St. Charles, and Aurora. E. C. Hawley, Pres.

SIOUX CITY, IA.—Chrys Moller, Receiver of the Sioux City Cable Ry. Co., has been granted permission to change the motive power of the road to electricity.

LEAVENWORTH, KAN.—The electric railway referred to last week is about nine miles long, and will cost about \$180,000.

PASADENA, CAL.—The Highland St. R. R. has been purchased by Eastern capitalists who have already commenced securing the right of way for a continuous electric railway from Santa Monica to the foot of the Lowe Mountain Ry.

YUMA, ARIZ.—The council has granted a franchise to Alphonso B. Smith, which includes an electric street railway and a steam railway from the Colorado River up Main St. and west to the city limits.

ELEVATED RAILWAYS.

CHICAGO, ILL.—The "Times" states that the Property Owners' Elevated R. R. is projected by Normal Williams, Hamilton Hunt, David Kelly, H. B. Hurd and others to unite the Alley, Metropolitan, Lake St. and proposed North Side elevated roads. The capital stock will probably be \$5,000,000, and it is proposed to give each property holder who signs for the road \$100 worth of stock for every front foot of land facing the road. The scheme includes the carrying free of all passengers from the various terminals of the elevated roads. Electric motors are contemplated, as

well as the laying of the rails on a rubber cushion. The road would have a single track, and as much as possible would run through alleys. In the same system it is proposed to construct an elevated movable sidewalk over the Wells St. bridge from the station of the Chicago & Northwestern Ry. to connect with this road.—The Central Construction Co. also has a scheme for connecting the various terminal stations of the elevated roads with an elevated movable sidewalk similar to the one on the pier at Jackson Park during the World's Fair.

The Lake St. elevated road will be opened this week for regular traffic from Market and Madison Sts. to California Ave., a distance of $4\frac{1}{2}$ miles, and in about two weeks trains will be running through to Garfield Park. From Garfield Park to 52d St., the western city limits, the structure is well under way and will be completed as soon as possible. The company is now considering routes for certain branches for which it has franchises. Surveys have been made and a statement of the definite routes must be filed with the city clerk before next January. It is thought probably that extensions and branches will be built to practically cover the West Side. Pres., John A. Roche; Vice-Pres., H. P. Thompson; Treas., J. H. Witbeck; Gen. Man., M. H. Alberger.

HIGHWAYS.

MASSACHUSETTS.—The commissioners of Worcester county gave a hearing at Southboro last week on the question of the proposed storage reservoir of the Boston water board. It is estimated that the changes in highways thus necessitated will cost \$300,000. Another hearing will be held Nov. 16.

NEW JERSEY.—The contract for macadamizing the road in Madison township from Old Bridge to Matawan, a distance of four miles, has been awarded to Joseph Wilson & Co., Dunellen, at \$1.65 per lin. ft. The other bids were B. M. & J. F. Shanly, Newark, \$1.79; Harry Riddle, O. O. Stillman and George Kuhn, New Brunswick, \$1.67; New Jersey Paving & Const. Co., Trenton, \$1.63.—The contract for macadamizing about five miles of the Scotch road from Trenton to Ewing has been awarded to R. A. Montgomery, Lambertville, at about \$50,000, according to reports.

MICHIGAN.—The citizens of Gogebic county have voted upon an issue of bonds for \$75,000 for improving the highways of the county.

WASHINGTON.—A hearing will be held at Tacoma Nov. 21 to consider a petition for a county road. W. A. Ryan, Co. Clk., Tacoma.

CALIFORNIA.—The supervisors of San Diego county will receive bids until Nov. 13 for a boulevard 30 ft. wide from National City to the south line of the National Ranch, on the line of the proposed boulevard around the bay. W. H. Holcomb, Clk. Bd., San Diego.

The citizens of Kern county have voted to issue bonds for \$250,000 for a public building at Bakersfield and to improve the highways leading to that city.—At a recent road convention in Sacramento county it was recommended that bonds for \$250,000 be issued to build macadamized roads, 16 ft. wide. It was thought that this sum would build five main roads from the city of Sacramento, each 12 miles long. Address B. N. Steinman, Mayor, Sacramento.

BRIDGES.

ALBANY, N. Y.—Bids are asked until Nov. 6 for an iron bridge over the Erie Canal at Genesee St., in the city of Utica, and for rebuilding bridge No. 15, known as the Fitzgerald bridge, over the Champlain Canal. The plans for the new bridge over the canal at Utica provide for two permanent roadways and two lift roadways of 17 ft. clear width each, and two foot bridges each 9 ft. in width. Edward Hannan, Supt. Pub. Wks.

FREDONIA, N. Y.—The town board has ordered an iron bridge to replace the wooden structure on the Brigham road, which was carried away by the high water recently.

TROY, N. Y.—It is reported probable that bids will soon be asked for a bridge over the Poestenkill River.

PHILADELPHIA, PA.—Plans have been approved for the Manayunk Ave. tunnel of the Wissahickon railway.

SHARON, PA.—The commissioners will receive bids until Nov. 4 for a new 180-ft. iron bridge across the Shenango River at this place.

LANSING, MICH.—An election will be held Nov. 9 to vote on an issue of \$85,000 of bridge and electric light bonds.

MILWAUKEE, WIS.—The following bids have been received for the substructure at the viaduct to span the Menomonee Valley: E. L. Barst, \$68,900; W. T. Duke, \$69,800; J. A. Meyers, \$74,800; Milwaukee Bridge & Iron Works, \$57,770; C. H. Starke, \$55,000; Wisconsin Bridge & Iron Co., \$73,787; E. Y. Ehlmann, \$58,900; T. R. Bentley, \$55,867; J. P. Sherer, \$53,997. Bid; will soon be received for the superstructure.

MANKATO, MINN.—Bids are asked until Nov. 14 for an iron bridge. John Mahowald.

RED WING, MINN.—The committee has drafted a resolution to vote \$75,000 of 5% bonds for a wagon bridge over the Mississippi River at this place. An effort has been made by the railway interests to secure a combination bridge.

OREAPOLIS, NEB.—Two spans of a bridge on the Burlington & Missouri River R. R., near this station, have been destroyed by fire.

WATER-WORKS.

CHELSEA, MASS.—A party from this city, Everett, Somerville and Boston made a trip last week with a view of again considering the Shawheen River as a probable source of water supply, especially for this city, Everett and Somerville.

CLINTON, MASS.—J. F. Philbin, Water Registrar, informs us that the contract for removing 26,000 cu. yds. of loam from the Lyndes reservoir has been awarded to Thos. F. Meany & Co., Quincy Point.

GLENDALE, MASS.—Chas. E. Butler is reported as building a reservoir for a new supply.

HAVERHILL, MASS.—Works will be put in at Nicholsville by Munroe Nichols.

LOWELL, MASS.—The present wells yield about 2,000,000 gallons per day and arrangements are being made by the contractor to secure an additional 3,000,000 gallons.

MARLBORO, MASS.—Work will soon be commenced

on a storage reservoir. There will be a dam 20 ft. high and 1,150 ft. long which will flow about 72 acres. The work this fall will be confined to clearing the wood and stripping the surface; also to the overflow, which is in rock. B. R. Felton, Cy. Engr.

MEDFORD, MASS.—The \$10,000 referred to last week has been appropriated for increasing the supply.

METHUEN, MASS.—Doyle & Cole have been awarded the contract for constructing the brick cover for the new reservoir, the work requiring about 200,000 brick, according to reports.

SOUTHBRIDGE, MASS.—The Southbridge Water Supply Co. has awarded the contract for the dam for a new 80,000,000-gallon reservoir to Lapham & Taylor, Northampton. The reservoir will be located $1\frac{1}{2}$ miles from the present reservoir. The contract for a 16-in. main has been awarded to the Inman Bros.' Construction Co., New York.

WATERBURY, CONN.—Bids are asked until Nov. 10 for 30,000 ft. 36-in. pipe and 200 tons special castings, as stated in our advertising columns. R. A. Cairns, Cy. Engr.

BROOKLYN, N. Y.—The contract for laying a new 48-in. main from the Ridgewood pumping station to the Ridgewood reservoir has been awarded to John McNamee.

NEWBURG, N. Y.—Bids have been opened for \$65,000 of water bonds.

JERSEY CITY, N. J.—Bids are asked until Nov. 6 for 350 ft. 48-in. cast iron pipe and 900 lbs. of lead. E. A. Dugan, Chn. Com.

SALEM, N. J.—An experimental well has been sunk to a depth of 240 ft. at the pumping station, at Quinton, and the superintendent is reported as stating that six wells will supply the city.

CLEARFIELD, PA.—The contract for works is reported to have been awarded to R. D. Wood & Co., Philadelphia, the supply to be from Montgomery Creek.

GLEN ROCK, PA.—A private company is being organized to put in works; capital stock, \$12,000.

KITTANNING, PA.—A new company is being organized, according to reports, the supply to be from the Allegheny River, the same as at present.

LIGONIER, PA.—L. W. Fogg has reported estimates for a 4-in. main to a running stream above Laughlins-town. Geo. Senft, Mem. Com.

PHILADELPHIA, PA.—Bids are asked until Nov. 7 for a 20,000,000-gallon engine, boilers, pipe, stand-pipe, etc. Jas. H. Windrim, Dir. Pub. Wks.

POTTSVILLE, PA.—The Good Spring Water Co. has been incorporated with a capital stock of \$2,500.

HARRISONBURG, VA.—The council has rescinded its action with regard to issuing bonds for extensions, referred to last week.

KEYSER, W. VA.—An election will be held Nov. 11 to vote on the issue of \$8,000 additional bonds to complete the works.

KEY WEST, FLA.—The commissioners are negotiating with R. D. Wood & Co., Philadelphia, for works.

HARRIMAN, TENN.—The contract for works has been awarded to H. W. Veazey, Harriman, at \$40,000, the payment to be made in city bonds, and work to be commenced at once. Cyrus Hanks, Cy. Clk.

HUMBOLDT, TENN.—At an election Oct. 27 the citizens voted to issue bonds for \$10,500 and to award a franchise for works and an electric light plant to a Memphis firm, according to reports.

CYNTHIANA, KY.—A proposition for works will be voted on at the election this month.

COLUMBUS, O.—The committee of the board of trade has recommended that an engineer be employed to make surveys for storage reservoirs; also that the city engineer prepare an estimate of the cost of a conduit to Lake Erie.

DAYTON, O.—About six miles of pipe will be laid in the new districts, the work to commence at once.

MANSFIELD, O.—It is proposed to adopt a meter system and to lay five or six miles of small pipe.

NORWALK, O.—The council has voted to issue bonds for \$6,000 for improvements, etc.

PLAIN CITY, O.—The contract for works, including a covered reservoir, has been awarded to Geo. Mercer & Co., Bowling Green, at \$17,445.

YOUNGSTOWN, O.—The citizens will vote next week on a proposition to issue bonds not to exceed \$186,000 for two 250,000-gallon stand-pipes, two 5,000,000-gallon pumps and for extensions.

JACKSON, MICH.—The proposition to issue bonds for \$20,000 was carried and the extensions will be made at once. The board of public works has been instructed to purchase pipe of the Addyston Pipe & Steel Co., Cincinnati, at a cost not to exceed \$19.90 per ton for pipe and \$45 per ton for specials.

CENTRALIA, ILL.—The council is negotiating the sale of \$30,000 of water bonds.

SOUTH MILWAUKEE, WIS.—About 33 bids were received for works, the successful ones being published under Contract Prices. Donsman & Sheldon, Engrs., Milwaukee.

BIWABIK, MINN.—It is reported that works will be put in, 1,400 ft. of pipe being laid this fall.

PARK RAPIDS, MINN.—The citizens have voted to issue bonds for \$8,000 for works, the construction to be commenced at once.

NEWTON, KAN.—Lewis Kingman, Topeka, has reported on proposed works; estimated cost, \$102,734.

OMAHA, NEB.—An election will be held Nov. 7 to vote on an issue of bonds for \$1,500,000 to build a canal from Platte River to within six miles of this city, a distance of 45 miles. The canal would be 80 ft. wide and 10 ft. deep, and have a fall of 123 ft. It is stated that it would furnish a supply of desirable water for the city, and would give about 27,500 HP. for manufacturing or other purposes.

SILOAM SPRINGS, ARK.—The citizens are considering the question of works.

BEEVILLE, TEX.—George Greathouse is interested in a proposed stock company to put in works.

DALLAS, TEX.—R. W. Haven, Cy. Engr., has prepared estimates for a dam for a storage reservoir at Record Mill crossing, on Elm Fork. The plans recommended include a pump house, \$2,095; pump and foundations, \$33,393; 300 ft. 36-in. pipe, \$3,125; 36-in. steel pipe laid, \$32,625; and a dam, \$18,750.

EDDY, TEX.—An artesian supply of 1,000,000 gallons daily has been secured, and works will be put in.

HENRIETTA, TEX.—Works will soon be put in, according to reports.

HILLSBORO, TEX.—The Hillsboro Water, Light & Power Co. will soon commence work on a system.

WAXAHACHIE, TEX.—It is reported that this place will soon have works.

GREELEY, COLO.—The city clerk wishes catalogues of water meters.

HOQUIAM, WASH.—The construction of works will be commenced as soon as the \$24,000 of bonds, recently voted, have been sold.

SPOKANE, WASH.—It was proposed to open bids about Nov. 10 for the new works, referred to last week.

SUMNER, WASH.—The election of July 3, at which bonds for \$17,000 were voted for works, has been decided legal, and the bonds will be issued.

TACOMA, WASH.—J. N. Fuller, of the board of public works, has proposed that the city secure a supply from the lakes. There are \$330,000 of funds available for the proposed extensions to Thomas and Patterson Springs, and it is thought the new project would cost but \$135,000, leaving a balance for extensions in the city.

DALLAS, ORE.—The citizens have voted to issue bonds for \$40,000 for works.

COLTON, CAL.—G. E. Slaughter, Cy. Clk., writes us that the question of building works will probably be voted on in April. An artesian supply is proposed with 12 miles of pipe line.

LOS ANGELES, CAL.—The council has rejected the offer of the private works for \$3,300,000, recently noted, as too high.

OAKLAND, CAL.—Proposals are wanted until Nov. 15 for a supply. W. G. Manuel, Mem. Com.

SANTA BARBARA, CAL.—The council is considering the advisability of purchasing the works.

YUMA, ARIZ.—The council has granted a franchise for a pumping plant for irrigation purposes and for a supply for the town to A. B. Smith, the work to be commenced within 30 days, according to reports.

IDAHO FALLS, IDAHO.—The citizens have voted to issue bonds for \$20,000 for municipal improvements, including works.

VANCOUVER, B. C.—All bids recently received for pipe were rejected as too high. The bids are published under Contract Prices.

MONCTON, N. B.—A committee has been appointed to consider the purchase of the works.

ARTESIAN WELLS.

BLUE ISLAND, ILL.—The village board is reported to have voted to sink an artesian well at an estimated cost of about \$15,000.

IRRIGATION.

PUEBLO, COLO.—The Orchard Grove Ditch & Reservoir Co. has been incorporated by F. C. Flory, L. W. Walker, L. B. Gould and Harry Wilkie, to construct an irrigation canal in Pueblo county, the water to be taken from the Arkansas River; capital stock, \$15,000.

WEISER, IDAHO.—The Payette & Weiser Canal Co. is preparing plans for a canal estimated to cost about \$50,000. T. P. Maryatt, Engr.

SEWERS.

NEWPORT, N. H.—The selectmen have been instructed to secure plans for a system.

BOSTON, MASS.—A petition has been presented for plans for sewers in that part of Dorchester known as the Forest Ave. district, together with estimates for draining Mattapan Brook.

BROCKTON, MASS.—The sewerage commissioners will receive bids until Dec. 1 for two pumping engines, two boilers, piping, etc. Each engine must be capable of raising 5,000,000 gallons of sewage per day 46 ft. through 16,560 ft. of 24-in. pipe. F. Herbert Snow, Cy. Engr.

LAWRENCE, MASS.—The council has voted a temporary loan of \$15,000 for sewers.

LOWELL, MASS.—The council has authorized the special loan of \$60,000 referred to last week.

MARLBORO, MASS.—The city council has voted to construct sewers in four streets, about 2,000 lin. ft. B. R. Felton, Cy. Engr.

NEW BRITAIN, CONN.—The commissioners are investigating the question of sewage purification by means of electricity.

BUFFALO, N. Y.—The department of public works will receive bids until Nov. 8 for four brick and tile sewers.—The following bids were received for a sewer in Humboldt Parkway: A. D. McConnell, \$10,000; Thomas B. Reading, \$15,607; John Munn, \$10,263; John Harter, \$11,000; E. J. Martin, \$14,485; W. G. Smith, \$11,933; Henry Harter, \$13,068; W. A. Green, \$10,480; W. A. Rappoch, \$15,184; Jacob Ritzman, \$12,691; William Franklin, \$12,242; August Gisel, \$10,500.

CANASTOTA, N. Y.—The sewer contract recently referred to has been awarded to Arthur D. Osborn, Binghamton, at \$6,139.

JAMESTOWN, N. Y.—The following bids were received Oct. 30 for the south side sewers: Standard Construction Co., Pittsburg, \$61,475, or \$61,220, according to the route; Wm. H. Roberts, Pittsburg, \$75,816, or \$75,476; Rider & Fitzgerald, Dunkirk, \$55,422.81, or \$53,803; Wm. Franklin, Buffalo, \$58,748, or \$58,188.

NEW YORK, N. Y.—The commissioner of public works will receive bids until Nov. 9 for five contracts.

NORTH TARRYTOWN, N. Y.—David Silver, J. T. Lawrence, Rev. George Daniels, George Sinnott and Michael Martin have been appointed a committee to consult with the board of health and village trustees concerning a system.

JERSEY CITY, N. J.—Bids are asked until Nov. 6 for 1,865 lin. ft. 24-in. brick oval sewer and for a main sewer, including 5,000 cu. yds. earth filling, 1,860 lbs. iron bolts, 60,000 ft. B. M. spruce and pine timber, 1,950 lin. ft. 48-in. brick sewer, 430 piles, 350 lin. ft. 48-in. cast iron water pipe, 300 lbs. lead, etc.; also until Nov. 13 for 7,000 lin. ft. piles, about 60,000 ft. timber, 700 lin. ft. 15-in. pipe sewer, etc. E. A. Dugan, Chn. Com.

ETNA, PA.—Bids are asked until Nov. 4 for a pipe sewer. J. L. Robertson, Chn. Com.

Pres., C. A. Tonner, Duluth; Secy., W. Potter, Minneapolis; Cons. Engr., E. Arnit, New York.